

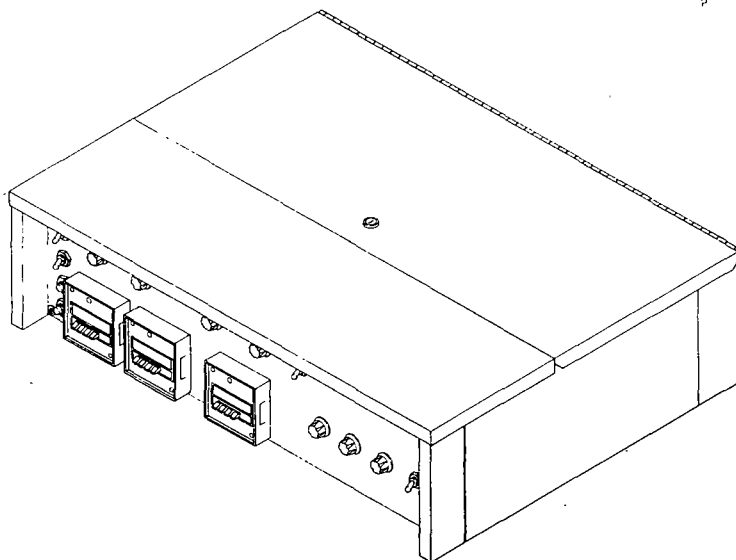


January 1991 FORM: OM-531C

Effective With Serial No. JK674521

MODEL: SP-1
SP-2
SP-3
SP-3-50
SP-4
SP-4-50

FILE COPY
RETURN TO FOLDER



OWNER'S MANUAL

IMPORTANT: Read and understand the entire contents of both this manual and the power source manual used with this unit, with special emphasis on the safety material throughout both manuals, before installing, operating, or maintaining this equipment. This unit and these instructions are for use only by persons trained and experienced in the safe operation of welding equipment. Do not allow untrained persons to install, operate, or maintain this unit. Contact your distributor if you do not fully understand these instructions.

MILLER ELECTRIC Mfg. Co.
A Miller Group Ltd., Company

P.O. Box 1079
Appleton, WI 54912 USA
Tel. 414-734-9821

LIMITED WARRANTY

EFFECTIVE: AUGUST 6, 1990

This warranty supersedes all previous MILLER warranties and is exclusive with no other guarantees or warranties expressed or implied.

LIMITED WARRANTY – Subject to the terms and conditions hereof, MILLER Electric Mfg. Co., Appleton, Wisconsin warrants to its Distributor/Dealer that all new and unused Equipment furnished by MILLER is free from defect in workmanship and material as of the time and place of delivery by MILLER. No warranty is made by MILLER with respect to engines, trade accessories or other items manufactured by others. Such engines, trade accessories and other items are sold subject to the warranties of their respective manufacturers, if any. All engines are warranted by their manufacturer for two years from date of original purchase, except Deutz engines which have a one year, 2000 hour warranty.

Except as specified below, MILLER's warranty does not apply to components having normal useful life of less than one (1) year, such as spot welder tips, relay and contactor points. MILLERMATIC parts that come in contact with the welding wire including nozzles and nozzle insulators where failure does not result from defect in workmanship or material.

MILLER shall be required to honor warranty claims on warranted Equipment in the event of failure resulting from a defect within the following periods from the date of delivery of Equipment to the original user:

1. Arc welders, power sources, robots, and 1 year components
2. Load banks 1 year
3. Original main power rectifiers 3 years (labor – 1 year only)
4. All welding guns, feeder/guns and torches 90 days
5. All other MILLERMATIC Feeders 1 year
6. Replacement or repair parts, exclusive of labor 60 days
7. Batteries 6 months

provided that MILLER is notified in writing within thirty (30) days of the date of such failure.

As a matter of general policy only, MILLER may honor claims submitted by the original user within the foregoing periods.

In the case of MILLER's breach of warranty or any other duty with respect to the quality of any goods, the exclusive remedies therefore shall be, at MILLER's option (1) repair or (2) replacement or, where authorized in writing by MILLER in appropriate cases, (3) the reasonable cost of repair or replacement at an authorized MILLER service station or (4) payment of or credit for the purchase price (less reasonable depreciation based upon actual use) upon return of the goods at Customer's risk and expense. MILLER's option of repair or replacement will be F.O.B., Factory at Appleton, Wisconsin, or F.O.B. at a MILLER authorized service facility, therefore, no compensation for transportation costs of any kind will be allowed. Upon receipt of notice of apparent defect or failure, MILLER shall instruct the claimant on the warranty claim procedures to be followed.

ANY EXPRESS WARRANTY NOT PROVIDED HEREIN AND ANY IMPLIED WARRANTY, GUARANTY OR REPRESENTATION AS TO PERFORMANCE, AND ANY REMEDY FOR BREACH OF CONTRACT WHICH, BUT FOR THIS PROVISION, MIGHT ARISE BY IMPLICATION, OPERATION OF LAW, CUSTOM OF TRADE OR COURSE OF DEALING, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR PARTICULAR PURPOSE, WITH RESPECT TO ANY AND ALL EQUIPMENT FURNISHED BY MILLER IS EXCLUDED AND DISCLAIMED BY MILLER.

EXCEPT AS EXPRESSLY PROVIDED BY MILLER IN WRITING, MILLER PRODUCTS ARE INTENDED FOR ULTIMATE PURCHASE BY COMMERCIAL/INDUSTRIAL USERS AND FOR OPERATION BY PERSONS TRAINED AND EXPERIENCED IN THE USE AND MAINTENANCE OF WELDING EQUIPMENT AND NOT FOR CONSUMERS OR CONSUMER USE. MILLER'S WARRANTIES DO NOT EXTEND TO, AND NO RESELLER IS AUTHORIZED TO EXTEND MILLER'S WARRANTIES TO, ANY CONSUMER.

RECEIVING-HANDLING

Before unpacking equipment, check carton for any damage that may have occurred during shipment. File any claims for loss or damage **with the delivering carrier**. Assistance for filing or settling claims may be obtained from the distributor and/or the equipment manufacturer's Transportation Department.

When requesting information about this equipment, always provide the Model Description and Serial or Style Number.

Use the following spaces to record the Model Designation and Serial or Style Number of your unit. The information is located on the data card or the nameplate.

Model _____

Serial or Style No. _____

Date of Purchase _____

TABLE OF CONTENTS

Section No.	Page No.
SECTION 1 – SAFETY PRECAUTIONS AND SIGNAL WORDS	
1-1. General Information And Safety	1
1-2. Safety Alert Symbol And Signal Words	1
SECTION 2 – SPECIFICATIONS	
2-1. Description	2
SECTION 3 – INSTALLATION	
3-1. Field Installation Instructions For Installing Programmer Onto Welding Power Source	2
3-2. Field Installation Of Pulser Into SP-1 And SP-3 Programmers	3
3-3. Remote Emergency Stop Switch Connections (Switch Not Supplied)	6
3-4. Remote Downslope Initiation Switch Connections (SP-3 And SP-4 Models) (Switch Not Supplied)	6
3-5. Remote Hand Switch Connections (SP-1 And SP-2 Models)	7
3-6. Remote Start Control Connections (SP-3 And SP-4) (Switch Not Supplied)	7
3-7. Timed Normally-Open And Normally-Closed Contacts (SP-3 And SP-4 Models)	7
SECTION 4 – OPERATOR CONTROLS	
4-1. Programmer Switch	8
4-2. Starting The Unit	8
4-3. Stopping The Unit	8
4-4. Electroslope (All Models)	9
4-5. Remote Downslope Initiation Switch (SP-3 And SP-4 Models)	10
4-6. Pulser (SP-2 And SP-4 Models)	10
4-7. Sequencer (SP-3 And SP-4 Models)	11
4-8. SMAW/GTAW Switch (SP-1 And SP-2 Models)	11
4-9. Auto/Manual Switch (SP-3 And SP-4 Models)	11
4-10. Remote Hand Switch RHS-46 (SP-1 And SP-2 Models)	11

SECTION 5 – SEQUENCE OF OPERATION

5-1.	Control Setup Checklist	12
5-2.	Gas Tungsten Arc Welding (GTAW)	12
5-3.	Shielded Metal Arc Welding (SMAW)	14
5-4.	Shutting Down	14

SECTION 6 – MAINTENANCE & TROUBLESHOOTING

6-1.	Electronic Timers	14
6-2.	Circuit Board Replacement Procedures	15
6-3.	Troubleshooting	16

SECTION 7 – ELECTRICAL DIAGRAMS

Diagram 7-1.	Circuit Diagram For SP-1 Models	18
Diagram 7-2 .	Circuit Diagram For SP-2 Models	19
Diagram 7-3 .	Circuit Diagram For SP-3 And SP-4 Models	20
Diagram 7-4.	Circuit Diagram For SP-1 Model Sloper Circuit Board PC500 .	21
Diagram 7-5.	Circuit Diagram For SP-2 Model Sloper Circuit Board PC500 .	22
Diagram 7-6.	Circuit Diagram For SP-3 Model Sloper Circuit Board PC500 .	23
Diagram 7-7.	Circuit Diagram For SP-4 Model Sloper Circuit Board PC500 .	24
Diagram 7-8.	Circuit Diagram For Pulser Circuit Board	25

SECTION 8 – PARTS LIST

Figure 8-1.	Main Assembly	26
Figure 8-2.	Circuit Card (Sloper And Pulser Illustrated)	28
Figure 8-3.	Pulser Control	31

LIST OF CHARTS AND TABLES

Table 2-1.	Specifications	1
Chart 4-1.	Weld Cycle Timing	9
Table 5-1.	Welding Power Source Control Checklist	13
Table 5-2.	Programmer Control Checklist	13
Table 6-1.	Troubleshooting	17

SECTION 1 – SAFETY PRECAUTIONS AND SIGNAL WORDS

1-1. GENERAL INFORMATION AND SAFETY

A. General

Information presented in this manual and on various labels, tags, and plates on the unit pertains to equipment design, installation, operation, maintenance, and troubleshooting which should be read, understood, and followed for the safe and effective use of this equipment.

B. Safety

The installation, operation, maintenance, and troubleshooting of arc welding equipment requires practices and procedures which ensure personal safety and the safety of others. Therefore, this equipment is to be installed, operated, and maintained only by qualified persons in accordance with this manual and all applicable codes such as, but not limited to, those listed at the end of Section 1 – Safety Rules For Operation Of Arc Welding Power Source in the welding power source Owner's Manual.

1-2. SAFETY ALERT SYMBOL AND SIGNAL WORDS

The following safety alert symbol and signal words are used throughout this manual to call attention to and identify different levels of hazard and special instructions.



This safety alert symbol is used with the signal words **WARNING** and **CAUTION** to call attention to the safety statements.



WARNING statements identify procedures or practices which must be followed to avoid serious personal injury or loss of life.



CAUTION statements identify procedures or practices which must be followed to avoid minor personal injury or damage to this equipment.

IMPORTANT statements identify special instructions necessary for the most efficient operation of this equipment.

SECTION 2 – SPECIFICATIONS

Table 2-1. Specifications

Power	Weight	
	Net	Ship
Operates From Welding Power Source Control Voltages	75 lbs. (34 kg)	78 lbs. (35.4 kg)

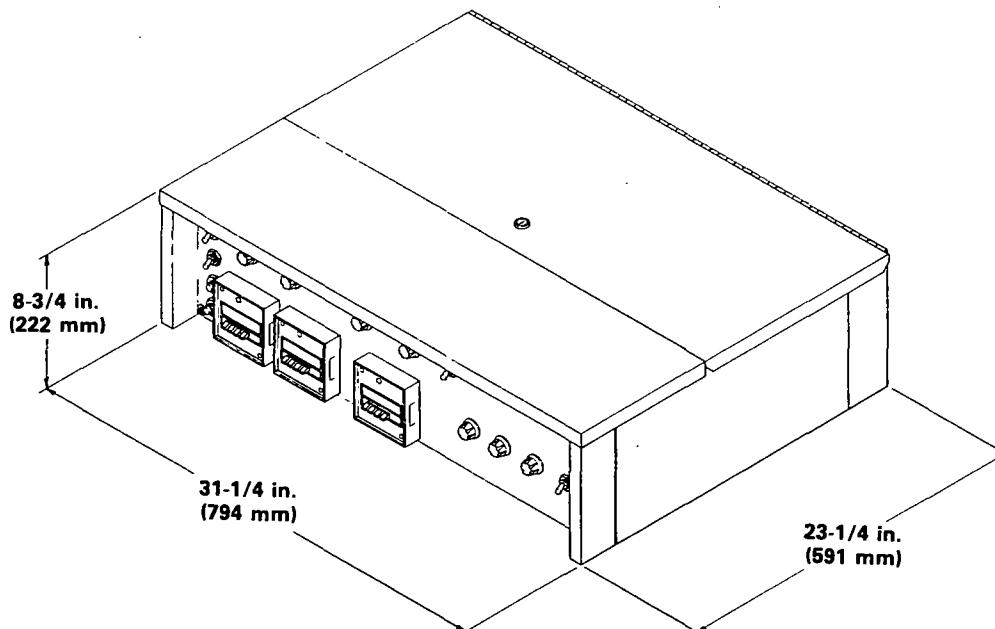


Figure 2-1. Specifications

TC-046 483

2-1. DESCRIPTION

The SP series is designed to program specific functions of the Syncrowave welding power source. All of the models are equipped with Electroslope which provides initial output selection, upslope time control, downslope time control, and final output selection.

The SP-1 is equipped with Electroslope. The SP-1 must be manually advanced through the welding cycle.

The SP-2 is equipped with Electroslope, and Pulser which provides background output control, pulse percent on time, and pulse frequency control. This programmer must also be manually advanced through the welding cycle.

The SP-3 is equipped with Electroslope, and a Sequencer which provides electronic control of initial output time, upslope and weld time, and downslope and final output time.

The SP-4 is equipped with Electroslope; Pulser, the same as SP-2; and Sequencer, the same as SP-3.

The locking rear compartment on the Programmer is designed for tool and torch storage. The welding power source lifting eye can be accessed through this compartment.

The welding power source and Programmer are referred to as the unit in this manual. When ordered as a factory option, the SP is installed on and wired into the welding power source. Field installation is possible and instructions are included in Section 3-1.

SECTION 3 – INSTALLATION

3-1. FIELD INSTALLATION INSTRUCTIONS FOR INSTALLING PROGRAMMER ONTO WELDING POWER SOURCE (Figures 3-1 And 3-2)



WARNING: ELECTRIC SHOCK can kill.

- Do not touch live electrical parts.
- Do not allow untrained persons to install this unit.
- Shut down welding power source, and disconnect input power employing lockout/tagging procedures before beginning this installation.

Lockout/tagging procedures consist of padlocking line disconnect switch in open position, removing fuses from fuse box, or shutting off and red-tagging circuit breaker or other disconnecting device.

This unit and these instructions are for use only by persons trained and experienced in the safe methods of working on welding equipment.

IMPORTANT: All directions such as left or right, are with respect to the operator facing the welding power source and Programmer front panels. Retain all hardware removed during this procedure for reinstallation.



CAUTION: METAL FILINGS AND/OR TOOL CONTACT WITH INTERNAL COMPONENTS can damage unit.

- Cover internal components.
- Clean unit, and remove internal covering material before resuming operation.

A . Mechanical Procedures

1. Remove top cover from Programmer.
2. Remove both side panels from welding power source.
3. Place Programmer on top of welding power source with front control panels facing same di-

rection, and align four mounting holes and lead access hole in Programmer with holes in top cover of welding power source.

4. Using the Programmer as a template, mark four mounting holes and lead access hole onto welding power source top cover.
5. Remove Programmer from top of welding power source.
6. Remove welding power source top cover.
7. Drill four 9/32 in. (7 mm) mounting holes in welding power source cover.
8. Drill or punch a 2-1/4 in. (57 mm) lead access hole in welding power source cover.

B . Electrical Connections

1. Locate terminal strip 1T in the welding power source.
2. Connect the following leads from 12-socket plug PLG2 to corresponding terminals on 1T:

11 to 1T11
20 to 1T20
32 to 1T32
68 to 1T68

IMPORTANT: It may be necessary to cut wiring harness ties to locate leads.

3. Locate leads B1 and 4 coming from pilot light PL1. Slide sleeving back on these leads to expose splices.



CAUTION: SOLDER can damage unit.

- Do not allow solder to fall into unit.
- Cover exposed areas of unit when soldering or unsoldering connections.
- Remove covers and clean unit before resuming operation.

4. Solder leads B1 and 4 from PLG2 to corresponding leads from PL1. Slide sleeving back into position after soldering.
5. Locate lead 11 coming from remote control receptacle RC2. Cut lead 11 approximately 6 in. (152 mm) from RC2.
6. Splice lead 144 from PLG2 to lead 11 coming from RC2.
7. Insulate free end of lead 11 and tie into wiring harness.
8. Locate lead 31 at contactor control switch S4. Connect lead 31 from PLG2 to S4 as follows:
 - a. Disconnect existing lead 31 from S4.
 - b. Reconnect lead 31 (from Step a) to piggyback connector on new lead 31.
 - c. Install piggyback connector onto S4 where lead 31 was removed in Step a.
9. Locate lead 109 at main amperage control R1. Unsolder lead from R1.
10. Solder lead 123 from PLG2 to R1 where lead 109 was removed.
11. Splice lead 109 to lead 109 coming from 9-socket plug PLG4.
12. Locate leads 107 at R1. Unsolder leads from R1.
13. Solder lead 115 from PLG2 to R1 where leads 107 were removed.
14. Splice leads 107 to lead 107 coming from PLG4.
15. Locate lead 114 at start amperage switch S10. Connect lead 114 from PLG4 to S10 as follows:
 - a. Disconnect existing lead 114 from S10.
 - b. Reconnect lead 114 (from Step a) to piggyback connector on new lead 114.
 - c. Install piggyback connector onto S10 where lead 114 was removed in Step a.
16. Connect the following leads from PLG4 to corresponding terminals on 1T:

86 to 1T86
81 to 1T81
17. Locate control transformer T2 just behind right end of 1T. Green transformer leads are leads 117 and 118. Slide sleeving back on these leads to expose the splices.
18. Splice leads 117 and 118 from PLG4 to corresponding leads from T2.

IMPORTANT: If the welding power source is equipped with Pulser, insulate end of lead 160 coming from PLG4, and tie into Programmer wiring harness.

19. Locate receptacle RC3 at circuit board PC1. Locate hole 27 on RC3.

20. Insert lead 160 from PLG4 into hole 27 at RC3. Be sure terminal on lead 160 is locked in RC3.
21. Connect lead 42 (ground) coming from PLG4 to one of the mounting bolts holding circuit board enclosure in place.
22. Tape or tie leads to existing wiring harness to maintain lead dress and to avoid contact with hot or moving parts.

C. Final Installation Procedures

1. Reinstall the welding power source cover.
2. Place the Programmer on top of the welding power source, and secure with supplied mounting screws.
3. Route 12-pin plug PLG1 and 9-pin plug PLG3 from Programmer through lead access hole into welding power source.
4. Connect PLG1 from Programmer to PLG2 in welding power source.
5. Connect PLG3 from Programmer to PLG4 in welding power source.
6. Reinstall side panels onto welding power source and cover onto Programmer.

3-2. FIELD INSTALLATION OF PULSER INTO SP-1 AND SP-3 PROGRAMMERS (Figures 3-1 thru 3-3)



WARNING: ELECTRIC SHOCK can kill.

- Do not touch live electrical parts.
- Do not allow untrained persons to install this unit.
- Shut down welding power source, and disconnect input power employing lockout/tagging procedures before beginning this installation.

Lockout/tagging procedures consist of padlocking line disconnect switch in open position, removing fuses from fuse box, or shutting off and red-tagging circuit breaker or other disconnecting device.

This unit and these instructions are for use only by persons trained and experienced in the safe methods of working on welding equipment.

IMPORTANT: All directions, such as left or right, are with respect to the operator facing the welding power source and Programmer front panels. Retain hardware removed during this procedure for reinstallation.

A. Mechanical Procedures

1. Remove top cover from Programmer.
2. Remove both side panels from the welding power source.



CAUTION: METAL FILINGS AND/OR TOOL CONTACT WITH INTERNAL COMPONENTS can damage unit.

- Cover internal components.
- Clean unit and remove internal covering material before resuming operation.

3. Holes are provided in the front panel but not in the nameplate for mounting the Pulser controls. Locate the four prepunched holes in the lower right corner of the front panel. Mark locations onto nameplate by applying pressure from rear with a sharp tool. Punch or drill holes of the same size in the nameplate.
4. Install the Pulser assembly from the rear of the front panel/nameplate, and secure with supplied hardware.
5. Apply the large label with control callouts onto the nameplate. Apply label with model designation onto lower right corner of nameplate.
6. Rotate Pulser controls fully counterclockwise, and install supplied knobs onto shafts with pointers at zero (0) or minimum.
7. A hole is provided in the front panel but not in the nameplate for mounting the ELECTROSLOPE switch S52. Locate the hole to the right of the electroslope controls. Mark location onto nameplate by applying pressure from rear with sharp tool. Punch or drill hole of same size in the nameplate.
8. Install the switch onto the front panel/nameplate from rear with switch keyway down.
9. Apply ELECTROSLOPE label over switch onto nameplate.
10. For SP-1 Models only: Install control relay CR56 to the front of the center partition in the Programmer under CR56 label using supplied hardware.
11. Locate circuit board PC500 on right side of center partition in the Programmer. Remove and discard PC500.

B. Electrical Procedures In Programmer



CAUTION: SOLDER can damage unit.

- Do not allow solder to fall into unit.
- Cover exposed areas of unit when soldering or unsoldering connections.
- Remove covers and clean unit before resuming operation.

1. Remove header RC50 from mounting bracket.

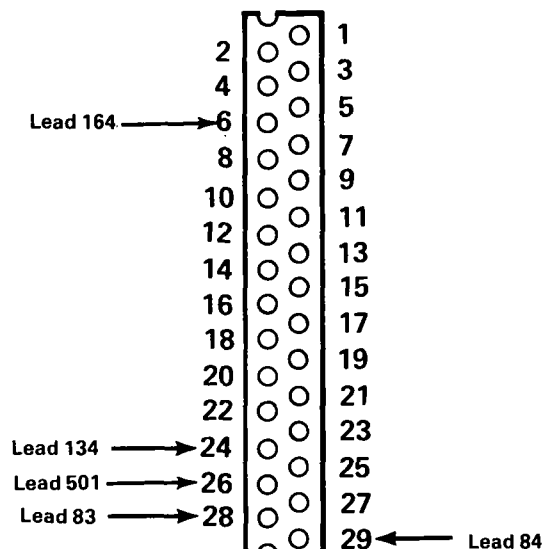


CAUTION: IMPROPER LEAD INSERTION can cause equipment damage.

- Be sure that lead terminals are inserted into correct receptacle hole. If a terminal does not lock in place when inserted into the receptacle, rotate terminal 180° and reinsert.

2. Insert the following leads from the pulser circuit board into RC50 (see Figure 3-1):

Lead 83 to RC50 Hole 28
 Lead 84 to RC50 Hole 29
 Lead 134 to RC50 Hole 24



TA-046 965

Figure 3-1. Receptacle RC50

3. For SP-1 Models:
 - a. Insert the following supplied loose leads into RC50 (see Figure 3-1).
 Lead 164 to RC50 Hole 6
 Lead 501 to RC50 Hole 26
 - b. Connect remaining end of lead 164 to terminal 7 on relay CR56.
 - c. Connect remaining end of lead 501 to the center terminal on the PULSER switch S400.
 - d. Connect supplied loose lead 31 to ELECTROSLOPE switch S52 (see Figure 3-2). Solder remaining end of lead 31 to the common terminal of STOP push button switch PB51.
 - e. Cut existing lead 139 4 in. (102 mm) from RC50. Disconnect remaining end from CR55 and discard. Splice supplied lead 139 to existing lead 139 at RC50 and insulate splice. Connect remaining end of new lead 139 to S52 (see Figure 3-2).
 - f. Disconnect existing lead 144 from rectifier SR3. Slide the supplied tubing onto lead 144. Connect the female terminals from existing lead 144 to the male terminals on supplied lead 144. Slide tubing over connection. Connect remaining end of lead 144 to S52 (see Figure 3-2). Connect short lead 144 to S52 (see Figure 3-2).
 - g. Connect supplied lead 156 to terminal on SR3 where lead 144 was removed. Connect remaining end of lead 156 to S52 (see Figure 3-2).
 - h. Connect supplied lead 155 to terminal A on CR56. Connect remaining end of lead 155 to S52 (see Figure 3-2).
 - i. Connect supplied lead 157 to terminal A on CR55. Connect remaining end of lead 157 to S52 (see Figure 3-2).

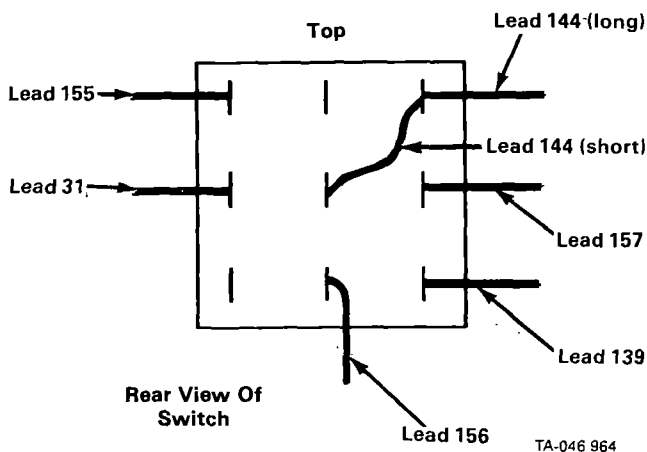


Figure 3-2. Electrical Installation Of Electroslope Switch S52 in SP-1 MODELS

- j. Disconnect existing lead 32 from SR3. Connect the female terminals from existing lead 32 to the male terminals on supplied lead 32. Connect remaining end of new lead 32 to terminal B on CR56.
- k. Connect supplied lead 109 to terminal 5 on CR56. Connect remaining end of lead 109 to PROGRAMMER switch S50 as follows:
 1. Disconnect existing lead 109 from S50.
 2. Connect lead 109 (from Step 1) to piggyback connector on new lead 109
 3. Install piggyback connector onto S50 where lead 109 was removed in Step 1.
- l. Cut off existing lead 130 4 in. (102 mm) from RC50. Unsolder remaining end of existing lead 130 from the FINAL AMPERAGE control R50 and discard. Solder supplied lead 130 to R50 where lead 130 was removed. Connect remaining end of new lead 130 to terminal 4 on CR56.
- m. Splice supplied lead 158 to existing lead 130 at RC50, and insulate splice. Connect remaining end of lead 158 to terminal 12 on CR56.
- n. Cut off existing lead 133 4 in. (102 mm) from RC50. Disconnect remaining end of lead 133 from S50 and discard. Splice supplied lead 133 to existing lead 133 at RC50 and insulate splice. Connect remaining end of new lead 133 to terminal 3 on CR56.
- o. Connect supplied lead 165 to the terminal on S50 where lead 133 was removed. Connect remaining end of lead 165 to terminal 11 on CR56.
- p. Cut existing lead 132 4 in. (102 mm) from RC50. Disconnect remaining end of lead 132 from S50 and discard. Splice supplied lead 159 to existing lead 132 at RC50 and insulate splice. Connect one of the remaining ends of new lead 159 to terminal 2 on CR56. Connect remaining end of new lead 159 to terminal 1 on CR56.

- q. Connect supplied lead 163 to the terminal on S50 where lead 132 was removed. Connect remaining end of lead 163 to terminal 9 on CR56.
4. For SP-3 Models
 - a. Connect supplied lead 501 to terminal 2 on CR55. Connect remaining end of lead 501 to center terminal of PULSER switch S400.
 - b. Connect supplied lead 81 to terminal 8 on CR55. Connect remaining end of lead 81 to the top terminal of S400.
 - c. Connect supplied long-lead 1 to terminal 13 on INITIAL AMPERAGE timer TD51. Connect remaining end of lead 1 to ELECTROSLOPE switch S52 (see Figure 3-3). Connect short lead 1 to S52 (see Figure 3-3).
 - d. Remove jumper link between terminals 71 and 161 on terminal strip 50T.
 - e. Connect supplied lead 71 to 50T71. Connect remaining end of lead 71 to S52 (see Figure 3-3).
 - f. Connect supplied lead 161 to 50T161. Connect remaining end of lead 161 to S52 (see Figure 3-3).
 - g. Disconnect existing lead 155 from terminal 3 on CR50 and terminal A on CR56 and discard. Connect supplied lead 155 as follows:
 1. Connect terminal with two leads to terminal A on CR56.
 2. Connect shorter lead to terminal 3 on CR50.
 3. Connect remaining lead to S52 (see Figure 3-3).
 - h. Connect supplied lead 157 to terminal 9 on TD51. Connect remaining end of lead 157 to S52 (see Figure 3-3).
 5. Connect supplied lead 160 to terminal 6 on CR56. Route remaining end of lead 160 through access hole in bottom of Programmer into welding power source.

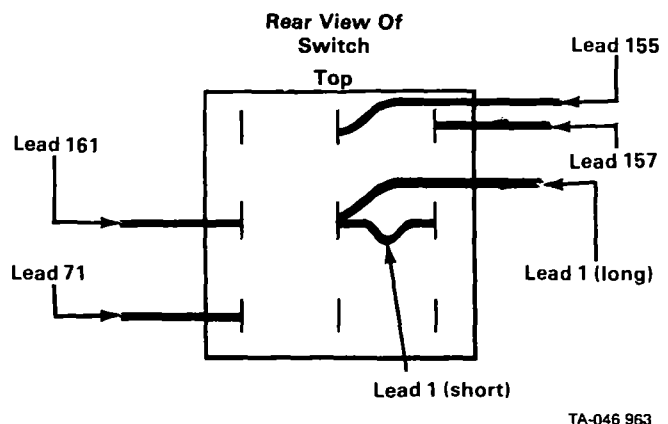


Figure 3-3. Electrical Installation Of Electroslope Switch S52 in SP-3 Models

6. Connect lead 42 from the pulser module to the threaded mounting spacer for Programmer circuit board PC500.
7. Connect lead 132 from the pulser module to terminal 10 on CR56.
8. Reinstall RC50.
9. Align supplied PC500 and insert into RC50. Secure PC500 to standoffs.
10. Thread leads 81, 86, and 114 from the pulser module, through the access hole in the bottom of the programmer, and into the welding power source.

C. Welding Power Source Electrical Connections

1. For Models Prior To Serial No. JA432849:
 - a. Splice supplied leads 81, 86, 114, and 160 to corresponding leads routed into the welding power source from the Programmer.
 - b. Connect leads 81 and 86 to corresponding terminals on terminal strip 1T in the welding power source.
 - c. Connect lead 114 to the START AMPERAGE switch S10 as follows:
 1. Disconnect existing lead 114 from S10.
 2. Reconnect lead 114 (from Step 1) to piggyback connector on new lead 114.
 3. Install piggyback connector onto S10 where lead 114 was removed in Step 1.
 - d. Locate edge connector receptacle RC3 at circuit board PC1. Insert lead 160 into hole 27 on RC3. Be sure that terminal on lead 160 has locked into RC3.
2. For Models Effective With Serial No. JA432849:
 - a. Discard supplied loose leads 81, 86, 114, and 160.
 - b. Insert leads from Programmer into plug PLG3 as follows:

Lead 81 to Socket 8
Lead 86 to Socket 6
Lead 114 to Socket 5
Lead 160 to Socket 7
 3. Tape or tie new leads to existing wiring harness. Be sure that leads will not touch hot or moving.
 4. Reinstall the welding power source side panels and Programmer top cover.

3-3. REMOTE EMERGENCY STOP SWITCH CONNECTIONS (Switch Not Supplied)



WARNING: ELECTRIC SHOCK can kill.

- Do not touch live electrical parts.
- Shut down welding power source, and disconnect input power employing lockout/tagging procedures before beginning this installation.

Lockout/tagging procedures consist of padlocking line disconnect switch in open position, removing fuses from fuse box, or shutting off and red-tagging circuit breaker or other disconnecting device.

IMPORTANT: All directions, such as left or right, are with respect to the operator facing the welding power source and Programmer front panels. Retain all hardware removed during this procedure for reinstallation.

A remote emergency stop switch may be installed into the Programmer. If remote emergency stop capability is desired, obtain switch and proceed as follows:

1. For SP-1 and SP-2 Models: Obtain a normally-open, momentary-contact switch. For SP-3 and SP-4 Models: Obtain a normally-closed, momentary-contact switch.
2. Remove Programmer top cover.
3. Route leads from switch through access hole on left side of Programmer.
4. Locate terminal strip 50T on left side of center partition.
5. For SP-1 and SP-2 Models: Connect leads from switch to terminals 31 and 148 on 50T.
6. For SP-3 and SP-4 Models: Remove jumper link between terminals 66 and 77 on 50T, and connect switch leads to 50T66 and 50T77.
7. Reinstall Programmer top cover.
8. Resume operation.

3-4. REMOTE DOWNSLOPE INITIATION SWITCH CONNECTIONS (SP-3 And SP-4 Models) (Switch Not Supplied)



WARNING: ELECTRIC SHOCK can kill.

- Do not touch live electrical parts.
- Shut down welding power source, and disconnect input power employing lockout/tagging procedures before beginning this installation.

Lockout/tagging procedures consist of padlocking line disconnect switch in open position, removing fuses from fuse box, or shutting off and red-tagging circuit breaker or other disconnecting device.

IMPORTANT: All directions, such as left or right, are with respect to the operator facing the welding power source and Programmer front panels. Retain all hardware removed during this procedure for reinstallation.

A normally-open, momentary-contact switch may be used for remote downslope initiation of the Programmer.

This switch may be manually operated or may be a fixture-mounted limit switch. If remote downslope initiation is desired, obtain switch and proceed as follows:

1. Remove Programmer top cover.
2. Route leads from switch through access hole in left rear of Programmer.
3. Locate terminal strip 50T on left side of Programmer rear panel.
4. Remove jumper links between terminals 64 and 162 on 50T.
5. Connect leads from switch to terminals 31 and 64 on terminal strip 50T.
6. Reinstall Programmer top cover.
7. Resume operation.

3-5. REMOTE HAND SWITCH CONNECTIONS (SP-1 And SP-2 Models)

The supplied remote hand switch, RHS-46, connects to the remote control receptacle on the welding power source. To make connections, align keyways, insert plug, and rotate collar fully clockwise.

3-6. REMOTE START CONTROL CONNECTIONS (SP-3 And SP-4) (Switch Not Supplied)

A normally-open, momentary-contact switch may be used for remote start control of the Programmer. If remote start control is desired, obtain switch and make connections between pins A and B of five-pin Amphenol plug supplied with welding power source. Align keyways, insert plug, and rotate threaded collar clockwise.

3-7. TIMED NORMALLY-OPEN AND NORMALLY-CLOSED CONTACTS (SP-3 And SP-4 Models) (Figure 3-4)

All timers have relay contacts available for control of external equipment such as movable fixtures. Equipment can only be connected to timer relay contacts that are not already in use. Each timer has instantaneous contacts that close when power is applied to the timer, and

delayed contacts that close when the timer times out. Timer terminal functions are as follows:

- Terminals: 1, 2 & 15 Provide Power To Timer
- 14 & 10 Instantaneous N.C.*
- 14 & 9 Instantaneous N.O.**
- 11 & 13 Delayed N.O.
- 12 & 11 Delayed N.C.
- 6 & 8 Instantaneous N.O.
- 7 & 6 Instantaneous N.C.
- 5 & 4 Delayed N.C.
- 4 & 3 Delayed N.O.

*Normally – Closed Contacts

**Normally – Open Contacts

To make connections to the timer relay contacts, proceed as follows:



WARNING: ELECTRIC SHOCK can kill.

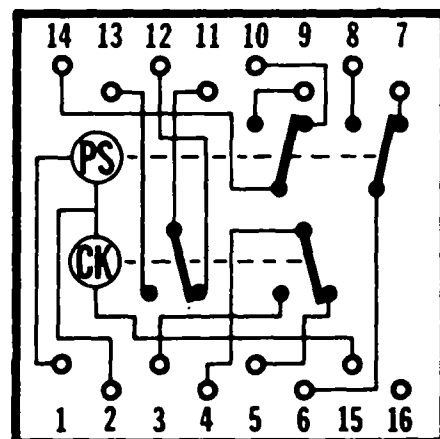
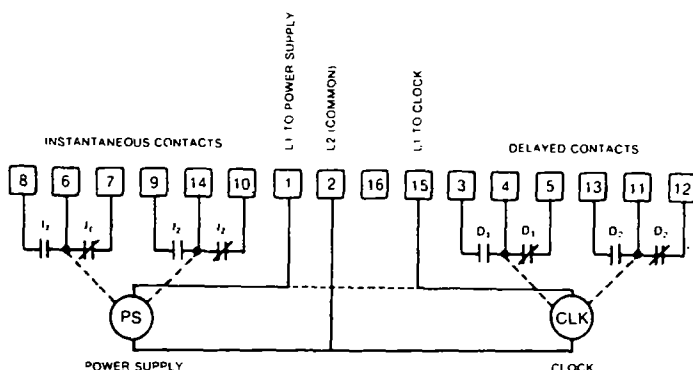
- Do not touch live electrical parts.
- Shut down welding power source, and disconnect input power employing lockout/tagging procedures before beginning this installation.

Lockout/tagging procedures consist of padlocking line disconnect switch in open position, removing fuses from fuse box, or shutting off and red-tagging circuit breaker or other disconnecting device.

IMPORTANT: All directions, such as left or right, are with respect to the operator facing the welding power source and Programmer front panels. Retain all hardware removed during this procedure for reinstallation.

IMPORTANT: Equipment can only be connected to relay contacts that are not already in use.

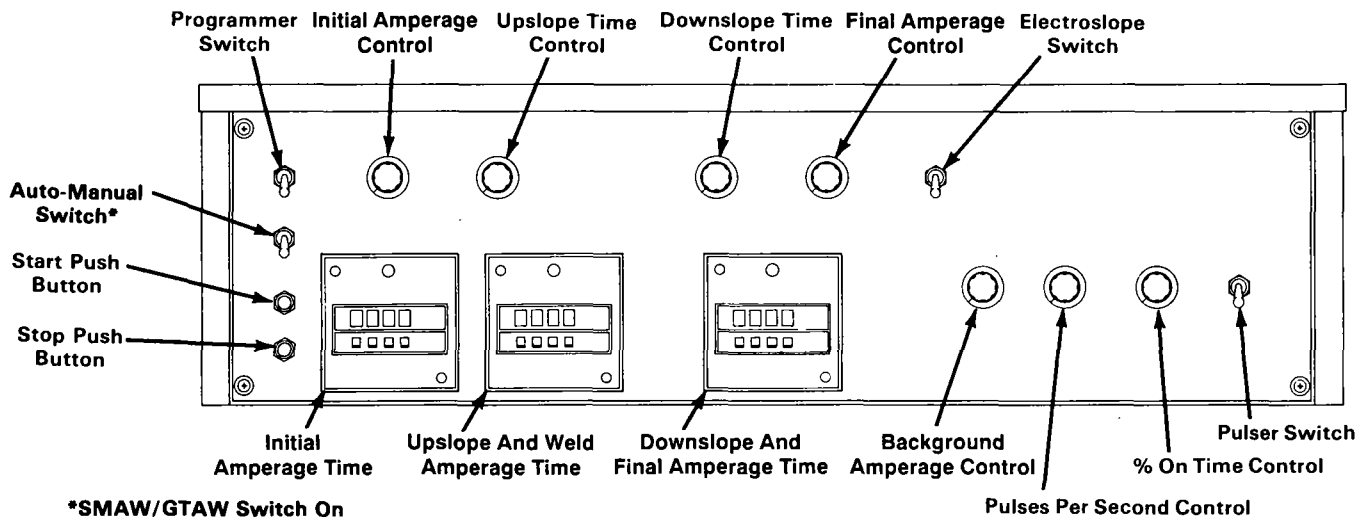
1. Remove Programmer top cover.
2. Route leads from external equipment through access hole in left rear of Programmer.
3. Locate appropriate timer and make connections (see Figure 3-4).
4. Reinstall Programmer top cover.



TA-114 384

Figure 3-4. Timer Rear View

SECTION 4 – OPERATOR CONTROLS



TC-046 482

Figure 4-1. Front Panel Controls

4-1. PROGRAMMER SWITCH (Figure 4-1)

When the PROGRAMMER switch is in the ON position, the Programmer is energized and ready to be programmed for the welding sequence. When in the OFF position, the programmer functions are not available and only the welding power source controls are functional.



CAUTION: INCORRECT SWITCH POSITION can cause equipment damage and personal injury.

- Place *AUTO/MANUAL* switch in the *MANUAL* position when the *PROGRAMMER* switch is in the *OFF* position.

The *AUTO* position causes the Programmer to automatically cycle through the preset program when the welding power source contactor is closed regardless of the *PROGRAMMER* switch position.

4-2. STARTING THE UNIT (Figure 4-1)

There are three ways to start the program: 1.) *START* push button switch on the Programmer, 2.) Remote Hand Switch *RHS-46* connected to welding power

source, 3.) remote start switch connected to welding power source.

The weld cycle begins when the *START* push button on the Programmer is pressed. The *START* push button is also used to cycle the Programmer through the various weld conditions.

The weld cycle can be started by using momentarily pressing the *RHS-46*. See Section 3-5 for switch specifications and connections.

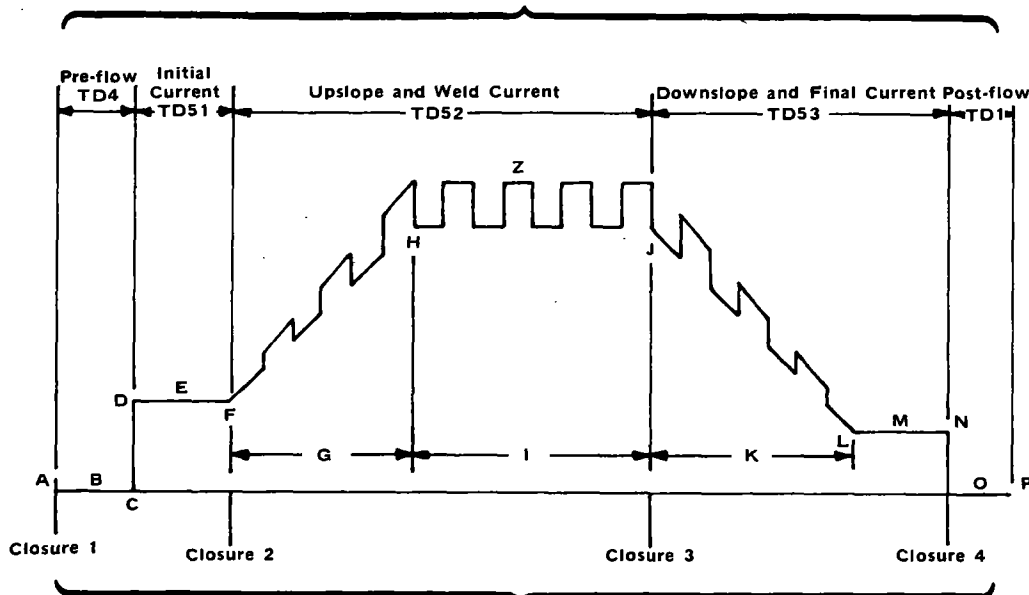
4-3. STOPPING THE UNIT (Figure 4-1)

When a normal weld program is run, the Programmer automatically resets to *OFF* at the end of the weld. There are two ways to stop the unit while welding: 1.) the *STOP* push button switch on the Programmer, and 2.) a remote emergency stop switch internally connected to terminal strip 1T in the Programmer.

The weld cycle stops and the unit resets when the *STOP* switch on the Programmer is pressed.

The weld cycle can be stopped using a remote emergency stop switch. See Section 3-3 for switch specifications and connections.

Chart 4-1. Weld Cycle Timing
Automatic Operation Using Electronic Timers



Manual Operation Using Remote Hand Switch (RHS-46)

TB-046 960

POINT FUNCTION

- A Programmer START button pressed.
- B Preflow timer in the welding power source begins to time.
- C Preflow ends. Welding power source contactor closes. High frequency available.
- D Arc started. INITIAL AMPERAGE and INITIAL AMPERAGE TIME controls active.
- E Initial amperage time.
- F UPSLOPE TIME and UPSLOPE AND WELD AMPERAGE TIME controls active. Pulsing starts if Pulser is ON.
- G Upslope time.
- H Weld time starts. Weld condition reached. Pulser controls may be adjusted.
- I Weld time.
- J DOWNSLOPE TIME and DOWNSLOPE AND FINAL AMPERAGE TIME controls active.
- K Downslope time.

- L FINAL AMPERAGE control active. Pulsing ends.
- M Final amperage time.
- N Arc extinguished. Postflow timer in welding power source begins to time.
- O Postflow time.
- P Weld sequence ends. Unit resets.

POINT SEQUENCE

1. Preflow timer in the welding power source times. Welding power source contactor closes. High frequency available. Arc starts and INITIAL AMPERAGE control is active.
2. UPSLOPE TIME control active. Pulsing starts if Pulser is on. Weld condition reached. Pulser controls may be adjusted.
3. DOWNSLOPE TIME control active. FINAL AMPERAGE control active. Pulsing ends.
4. Arc extinguished. postflow timer in welding power source times. Weld sequence ends. Unit resets.

4-4. ELECTROSLOPE (Figures 4-1 And 4-2) (All Models)

The electroslope allows the operator to preset the initial weld condition, an upslope time, a downslope time, and a final weld condition.

A. ELECTROSLOPE Switch

When the ELECTROSLOPE switch is in the ON position, all Programmer controls are functional. When the switch is in the OFF position, the Electroslope controls are not functional.

B. INITIAL AMPERAGE Control

The Initial Amperage circuitry allows the operator to set a starting output that is above or below the setting of the AMPERAGE CONTROL on the welding power source.

Rotating the control clockwise increases output. The scale surrounding the INITIAL AMPERAGE control represents a percentage of the welding power source AMPERAGE CONTROL and not an actual amperage value.

C. UPSLOPE TIME Control

The UPSLOPE TIME control sets the time it takes for the weld output to slope from the setting of the Programmer INITIAL AMPERAGE control to the setting of the welding power source AMPERAGE CONTROL.

Rotating the control clockwise increases time. The scale surrounding the control is calibrated directly in seconds (0 to 10).

D. DOWNSLOPE TIME Control

The DOWNSLOPE TIME control sets the time it takes for the weld output to slope from the setting of the welding power source AMPERAGE CONTROL to the setting of the Programmer FINAL AMPERAGE CONTROL.

Rotating the control clockwise increases time. The scale surrounding the control is calibrated directly in seconds (0 to 10).

E. FINAL AMPERAGE Control

The Final Amperage circuitry allows the operator to set an output that is above or below the setting of the AMPERAGE CONTROL on the welding power source for finishing the weld.

Rotating the control clockwise increases output. The scale surrounding the FINAL AMPERAGE control represents a percentage of the welding power source AMPERAGE CONTROL and not an actual amperage value.

4-5. REMOTE DOWNSLOPE INITIATION SWITCH (SP-3 And SP-4 Models)

If remote control of downslope initiation is desired, obtain and install switch according to Section 3-4.

When the Remote Downslope Initiation Switch is closed, downslope starts. This allows the operator to manually control the main weld time.

4-6. PULSER (SP-2 And SP-4 Models) (Figures 4-1 And 4-2, And Chart 4-1)

Pulsing refers to the alternate raising and lowering of the weld output at a periodic rate. The raised portions of the weld output are controlled in width, frequency, and height, forming pulses of weld output. These pulses and the lower output between them (called the background amperage) alternately heat and chill the molten weld puddle. The combined effect gives the operator better control of penetration, bead width, crowning, undercutting, and puddle sag in out-of-position welding, especially vertical-up.

When the Electroslope is used with the Pulser, the initial and final output are not pulsed. Pulsing begins at upslope, continues through the weld portion of the cycle, and ends when downslope is finished.

IMPORTANT: *The Pulser controls may be adjusted while welding.*

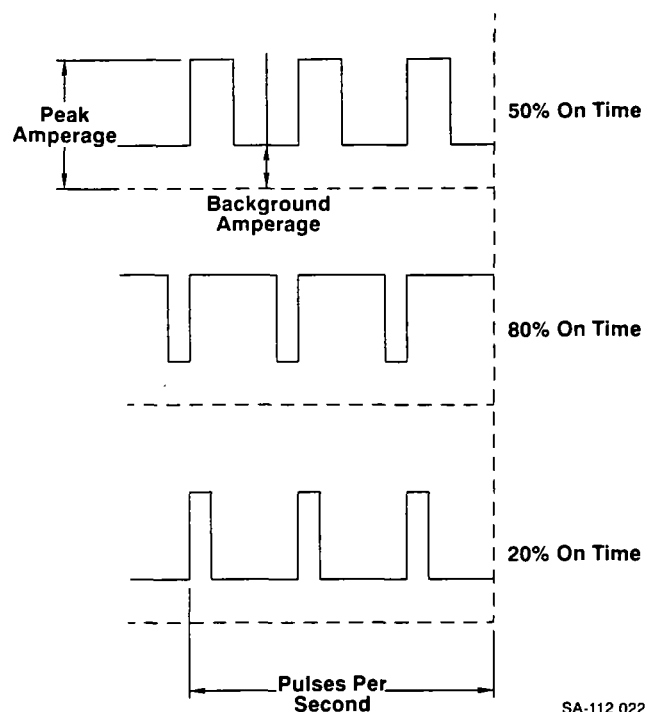


Figure 4-2. Pulsed Output

A. PULSER Switch

Placing the PULSER switch in the ON position activates the pulsing circuitry in the Programmer. The % ON TIME, PULSES PER SECOND, and BACKGROUND AMPERAGE controls must be adjusted to provide the proper pulse width, frequency, and height. When this switch is in the OFF position, the Pulser controls are not functional.

B. % ON TIME Control

The % ON TIME control provides pulse width selection and is active only when the PULSER switch is ON.

Rotating the % ON TIME control clockwise increases the peak output time in relation to the entire pulse time. The scale surrounding this control is calibrated in percent (5 to 95) and represents peak output on time during one pulse.

C. PULSES PER SECOND Control

The PULSES PER SECOND control provides pulse frequency selection and is active only when the PULSER switch is ON.

Rotating this control clockwise increases pulse frequency. The scale surrounding the PULSES PER SECOND is calibrated in pulses per second from 0.5 to 10 PPS.

D. BACKGROUND AMPERAGE Control

The BACKGROUND AMPERAGE control sets the weld output background level. The AMPERAGE CONTROL on the welding power source sets the peak output level during pulsed welding.

These controls act independently; therefore, it is possible to set a background amperage higher than the peak output.

Rotating the control clockwise increases background amperage. The scale surrounding the BACKGROUND AMPERAGE control is calibrated in percentage and should not be read as an amperage value.

4-7. SEQUENCER (SP-3 And SP-4 Models) (Figure 4-1 and Chart 4-1)

The Sequencer times the initial output, starts the upslope timer in the Electroslope, times the weld portion of the cycle, starts the downslope timer in the Electroslope, and times the final output.

To set desired time, press the lever directly below each digit. The levers can be pressed down or pushed up. These timers are factory set for the time down and stop mode of operation.

IMPORTANT: *1/10 (0.1) minute equals 6 seconds. 1/100 (0.01) minute equals 0.6 seconds. A setting of 2.21 minutes equals 2 minutes and 12.6 seconds.*

A. INITIAL AMPERAGE TIME

The INITIAL AMPERAGE TIME control allows the operator to choose the length of time that the INITIAL AMPERAGE control on the Programmer is active.

The INITIAL AMPERAGE TIME control can be set for 0.00–99.9 seconds. When this control times out, the UPSLOPE TIME control in the Electroslope is activated.

B. UPSLOPE AND WELD AMPERAGE TIME

The UPSLOPE AND WELD AMPERAGE TIME control sets the entire time between the start of upslope and the beginning of downslope. To determine the proper time, add the setting of the Electroslope UPSLOPE TIME control to the desired weld time. The total time should be set on the UPSLOPE AND WELD AMPERAGE TIME control.

The UPSLOPE AND WELD AMPERAGE TIME control can be set for 00.0–99.9 minutes. When this control times out, the DOWNSLOPE TIME control in the Electroslope is activated.

C. DOWNSLOPE AND FINAL AMPERAGE TIME

The DOWNSLOPE AND FINAL AMPERAGE TIME control sets the entire time between the start of downslope and the beginning of postflow. To determine the proper time, add the setting of the Electroslope DOWNSLOPE TIME control to the desired final amperage time. The total time should be set on the DOWNSLOPE AND FINAL AMPERAGE TIME control.

The DOWNSLOPE AND FINAL AMPERAGE TIME control can be set for 00.0–99.9 seconds. When this control times out, postflow starts.

4-8. SMAW/GTAW SWITCH (SP-1 And SP-2 Models) (Figure 4-1)

When the switch is in the SMAW position, weld output remains at the level set for the sequence when the arc is broken during any portion of the program.

When the switch is in the GTAW position, weld output resets to the INITIAL AMPERAGE control setting when the arc is broken during the weld, downslope, or final portions of the program.

4-9. AUTO/MANUAL SWITCH (SP-3 And SP-4 Models) (Figure 4-1)



WARNING: UNEXPECTED WELD OUTPUT can cause serious personal injury or damage to weldment or equipment.

- If use of the Programmer is not desired, ALWAYS place the AUTO/MANUAL switch in the MANUAL position.
- If in AUTO position, closing the remote contactor device or pressing the Programmer START button will energize the welding power source, and it will NOT deenergize unless one of the following is done:
 1. Place AUTO/MANUAL switch in MANUAL position
 2. Press STOP button on Programmer
 3. Turn off welding power source.

When the switch is in the AUTO position, the unit automatically cycles through all programmed sequences when the START push button switch is pressed. Weld output is determined by the amperage setting for the sequence.

When the switch is in the MANUAL position, the program consists of the initial condition, upslope, and an untimed weld condition. The START push button switch or remote start switch must be maintained closed while welding.

4-10. REMOTE HAND SWITCH RHS-46 (SP-1 And SP-2 Models) (Chart 4-1)

It is necessary to press the Remote Hand Switch RHS-46 each time a new or different weld condition is desired. This switch allows the operator to manually control the selection of the welding condition and the duration of that condition from a remote station.

SECTION 5 – SEQUENCE OF OPERATION



WARNING: ELECTRIC SHOCK can kill; MOVING PARTS can cause serious injury; IMPROPER AIR FLOW AND EXPOSURE TO ENVIRONMENT can damage internal parts.

- *Do not touch live electrical parts.*
- *Keep all covers and panels in place while operating.*

Warranty is void if the unit is operated with any portion of the outer enclosure removed.

ARC RAYS, SPARKS, AND HOT SURFACES can burn eyes and skin, NOISE can damage hearing.

- *Wear correct eye, ear, and body protection.*

FUMES AND GASES can seriously harm your health.

- *Ventilate to keep from breathing fumes and gases.*
- *If ventilation is inadequate, use approved breathing device.*

HOT METAL, SPATTER, AND SLAG can cause fire and burns.

- *Watch for fire.*
- *Have fire extinguisher nearby, and know how to use it.*
- *Allow work and equipment to cool before handling.*

MAGNETIC FIELDS FROM HIGH AMPERAGES can affect pacemaker operation.

- *Wearers should consult with their doctor before going near arc welding, gouging, or spot welding operations.*

See Section 1 – Safety Rules For Operation Of Arc Welding Power Source in the welding power source Owner's Manual for basic welding safety information.

5-1. CONTROL SETUP CHECKLIST (Tables 5-1 And 5-2)

The following tables provide the operator with a quick checklist approach to setting switch positions and controls for the Shielded Metal Arc (SMAW) and Gas Tungsten Arc (GTAW) Welding processes. Specific control settings depend on the process application.

IMPORTANT: See the welding power source Owner's Manual for information on function of controls.

5-2. GAS TUNGSTEN ARC WELDING (GTAW)



WARNING: Read and follow safety information at beginning of entire Section 5 before proceeding.

1. Install and connect unit according to Section 3 of this manual and the welding power source Owner's Manual.
2. Wear dry insulating gloves and clothing, and wear welding helmet with proper filter lens according to ANSI Z49.1.
3. Prepare for welding as follows:
 - a. Connect work clamp to clean, bare metal at workpiece.
 - b. Select and obtain proper tungsten electrode.
 - c. Prepare tungsten electrode according to welding power source Owner's Manual, and insert into torch.
4. Program the weld sequence by setting switches and controls according to Section 5-1.
5. Turn on the shielding gas.
6. Place PROGRAMMER switch in the ON position.
7. Place welding power source power switch in the ON position.
8. Push Programmer START push button or remote switch (see Sections 3-5, 3-6, and 4-2).
 - a. For GTAW mode: The START push button switch or Remote Hand Switch RHS-46 must be momentarily closed each time a new sequence is desired.
 - b. For AUTO mode: Once the Start switch is momentarily closed, the unit automatically cycles through the weld program.
 - c. For MANUAL mode: The Start switch must be held closed during the entire program. The INITIAL AMPERAGE TIME and PERCENTAGE UPSLOPE RATE controls function but the weld time is manually controlled. The unit stops and resets as soon as the Start switch is opened (no downslope or final conditions).
9. Adjust controls as necessary.

IMPORTANT: For SP-1 and SP-2 models: If an arc outage occurs at any point in the program, the amperage setting reverts to that of the INITIAL AMPERAGE control for arc starting. For SP-3 and SP-4 models: If an arc outage occurs during the initial, upslope, or weld conditions, the welding power source contactor opens and weld output is not available. The Programmer continues to the end of the cycle and resets.

Table 5-1. Welding Power Source Control Checklist

Welding Power Source Controls	SMAW	GTAW
CONTACTOR Switch	OFF	ON
AMPERAGE Switch	As Desired	As Desired
AMPERAGE CONTROL	As Desired	As Desired
HIGH FREQUENCY Switch	OFF	As Desired
CRATER FILL Switch	As Desired	OFF
AMPERAGE Switch	As Desired	OFF
AMPERAGE Control	As Desired	Not Applicable
AC BALANCE Control	As Desired	As Desired
*POST-FLOW TIME control	0	As Desired
*SPOT TIMER Switch	OFF	OFF
*SPOT TIME Control	Not Applicable	Not Applicable
PRE-FLOW TIME Switch	OFF	As Desired
PRE-FLOW TIME Control	Not Applicable	As Desired
*PULSER Switch	OFF	OFF
*% ON TIME Control	Not Applicable	Not Applicable
PULSES PER SECOND Control	Not Applicable	Not Applicable
*BACKGROUND AMPERAGE Control	Not Applicable	Not Applicable
AC/DC Selector Switch	As Desired	As Desired
RANGE Switch	As Desired	As Desired
POLARITY Switch	As Desired	As Desired

*If so equipped.

Table 5-2. Programmer Control Checklist

Programmer Controls	SMAW	GTAW
PROGRAMMER Switch	+ON	OFF
SMAW/GTAW Switch or AUTO/MANUAL Switch	SMAW MANUAL	GTAW As Desired
INITIAL AMPERAGE Control	Not Applicable	As Desired
*INITIAL AMPERAGE TIME	Not Applicable	As Desired
UPSLOPE TIME Control	Not Applicable	As Desired
*UPSLOPE AND WELD AMPERAGE TIME	Not Applicable	As Desired
DOWNSLOPE TIME Control	Not Applicable	As Desired
*DOWNSLOPE AND FINAL AMPERAGE TIME	Not Applicable	As Desired
FINAL AMPERAGE Control	Not Applicable	As Desired
*ELECTROSLOPE Switch	OFF	ON**
*PULSER Switch	+ON	As Desired
*% ON TIME Control	As Desired	As Desired
*PULSES PER SECOND Control	As Desired	As Desired
BACKGROUND AMPERAGE Switch	As Desired	As Desired

*If so equipped.

+If pulsing is desired. If a remote control is used, both the peak output and background output are varied by the remote control in the same proportion as the settings of the Programmer BACKGROUND AMPERAGE control and the welding power source AMPERAGE CONTROL.

**If Electroslope is not used, welding power source START AMPERAGE circuit may be used.

5-3. SHIELDED METAL ARC WELDING (SMAW)



WARNING: Read and follow safety information at beginning of entire Section 5 before proceeding.

1. Install and connect unit according to Section 3 of this manual and the welding power source Owner's Manual.
2. Program the weld sequence by setting switches and controls according to Section 5-1.
3. Place PROGRAMMER switch in the ON position.
4. Place the welding power source switch in the ON position.
5. Adjust controls as necessary.
6. Wear dry insulating gloves and clothing, and wear welding helmet with proper filter lens according to ANSI Z49.1.
7. Prepare for welding as follows:
 - a. Connect work clamp to clean, bare metal at workpiece.
 - b. Select and obtain proper electrode, and insert into electrode holder.
8. Push Programmer START push button or remote switch (see Sections 3-5, 3-6, and 4-2).
 - a. For SMAW mode: Pulsing starts as soon as the Start switch is closed if pulsing is selected.

- b. For MANUAL mode: The Start switch must be held closed during the entire program. Releasing the Start switch ends the program. Pulsing starts as soon as the Start switch is closed if pulsing is selected.

IMPORTANT: If an arc outage occurs, the welding power source contactor remains closed and weld output is available at the level set by the welding power source AMPERAGE CONTROL for restarting the arc.

9. Adjust controls as necessary.
10. Begin welding.

5-4. SHUTTING DOWN

1. Stop welding and allow the Programmer to reset.

IMPORTANT: It may be necessary to manually cycle the Programmer to the end of the weld program through use of the START push button switch or Remote Hand Switch RHS-46.

2. Place PROGRAMMER switch in OFF position.
3. Place the welding power source POWER switch in the OFF position.
4. Turn off shielding gas at source, if applicable.



WARNING: HIGH CONCENTRATION OF SHIELDING GAS can harm health or kill.

- Shut off gas supply when not in use.

SECTION 6 – MAINTENANCE & TROUBLESHOOTING

IMPORTANT: Every six months inspect the labels on this unit for legibility. All precautionary labels must be maintained in a clearly readable state and replaced when necessary. See Parts List for part number of precautionary labels.

6-1. ELECTRONIC TIMERS (Figure 6-1)



WARNING: ELECTRIC SHOCK can kill.

- Do not touch live electrical parts.
- Shut down welding power source, and disconnect input power employing lockout/tagging procedures before inspecting, maintaining, or servicing.

Lockout/tagging procedures consist of padlocking line disconnect switch in open position, removing fuses from fuse box, or shutting off and red-tagging circuit breaker or other disconnecting device.

The electronic timers are factory set for either 50 or 60 Hertz operation (depending on the model), the time

down and stop mode, and either 00.0 – 99.9 second or 00.0 – 99.9 minute timing. To change any of these features, proceed as follows:

1. Fully loosen two screws on timer faceplate.
2. Pull timer out of case. This requires a firm grip.
3. To change from 60 Hertz to 50 Hertz, reconnect pin on left side of timer to 50 HZ pin.
4. To change from the time down and stop mode, reconnect pin on right side of timer to desired terminal: Up & Go, Down & Go, or Up & Stop.
5. To change time unit, apply slight pressure with a pen or pencil point to metal arm in slotted arc on right side of timer, and move arm to appropriate unit.
6. To change level of accuracy, use finger force to move white plastic lever located behind timer face until decimal point is at desired level.
7. Reinstall timer into case, and secure screws on timer faceplate.

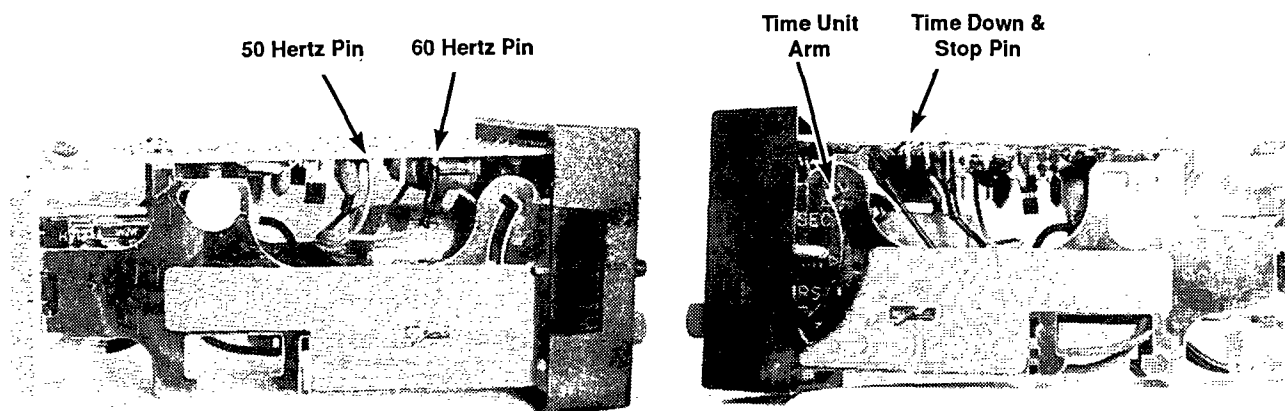


Figure 6-1. Changing Timer Operations

6-2. CIRCUIT BOARD REPLACEMENT PROCEDURES (Figure 6-2)

If a circuit board is found to be faulty, replace board using the following procedure. Do not attempt board repair.

Contact the nearest Factory Authorized Service Station for correct replacement part.



WARNING: ELECTRIC SHOCK can kill.

- Do not touch live electrical parts.
- Shut down welding power source, and disconnect input power employing lockout/tagging procedures before inspecting, maintaining, or servicing.

Lockout/tagging procedures consist of padlocking line disconnect switch in the open position, removing fuses from fuse box, or shutting off and red-tagging circuit breaker or other disconnecting device.



CAUTION: ELECTROSTATIC DISCHARGE (ESD) can damage circuit board.

- Put on properly grounded wrist strap **BEFORE** handling circuit boards.
- Transport all circuit boards in proper static-shielding carriers or packages.
- Perform work only at a static-safe work area.

INCORRECT INSTALLATION or misaligned plugs can damage circuit board.

- Be sure that plugs are properly installed and aligned.

EXCESSIVE PRESSURE can break circuit board.

- Use only minimal pressure and gentle movement when disconnecting or connecting board plugs and removing or installing board.

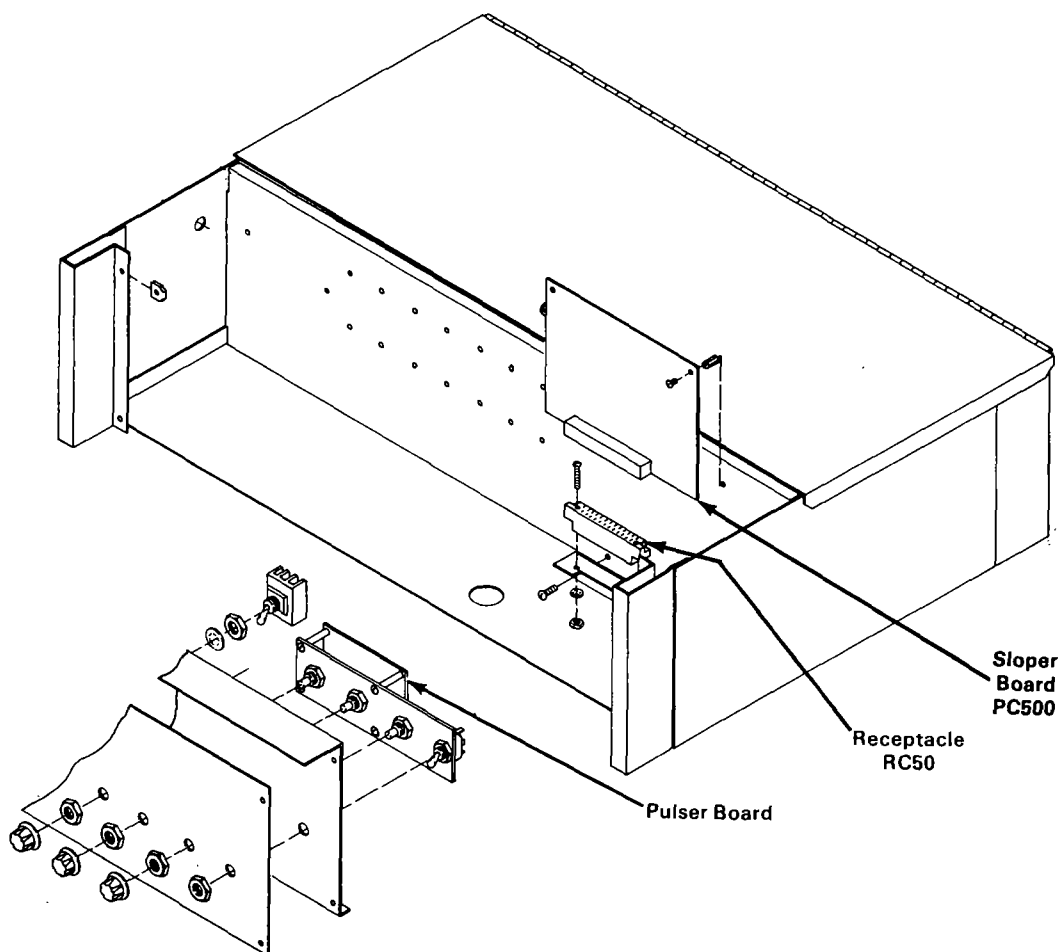
IMPORTANT: All directions, such as left or right, are with respect to the operator facing the unit front panel. Retain all hardware removed during this procedure for reinstallation.

A. Sloper Board PC500 Replacement

1. Remove Programmer top cover.
2. Locate and examine PC500 noting mounting position and receptacle location (see Figure 6-2).
3. Remove the screws securing PC500 to unit, and pull PC500 from receptacle RC50.
4. Align new PC500 and insert into RC50. Secure PC500 using screws removed in Step 3.
5. Reinstall Programmer top cover.

B. Pulser Board Replacement

1. Remove Programmer top cover.
2. Locate and examine pulser board noting mounting position and connector locations (see Figure 6-2).
3. Pull plugs straight off board and allow to hang free on wiring harness.
4. Remove the nuts and lock washers securing the board, and remove board from standoffs.
5. Position new board so that connectors are in same location as previously noted.
6. Install new board using lock washers and nuts removed in Step 4.
7. Reinstall plugs onto new board with keyways aligned. Connectors only go together completely one way.
8. Reinstall Programmer top cover.



Ref. TD-046 484-A

Figure 6-2. Circuit Board Replacement

6-3. TROUBLESHOOTING (Table 6-1)



WARNING: ELECTRIC SHOCK can kill.

- Do not touch live electrical parts.
- Shut down welding power source, and disconnect input power employing lockout/tagging procedures before inspecting or servicing.

Lockout/tagging procedures consist of padlocking line disconnect switch in the open position, removing fuses from fuse box, or shutting off and red-tagging circuit breaker or other disconnecting device.

HOT SURFACES can cause severe burns.

- Allow cooling period before servicing.

Troubleshooting to be performed only by qualified persons.

It is assumed that the unit was properly installed according to Section 3 of this manual, the operator is familiar with the function of controls, the unit was working properly, and that the trouble is not related to the welding

process. The following table is designed to diagnose and provide remedies for some of the troubles that may develop in this unit.

Use this table in conjunction with the circuit diagram while performing troubleshooting procedures. If the trouble is not remedied after performing these procedures, contact the nearest Factory Authorized Service Station. In all cases of equipment malfunction, the manufacturer's recommendations should be strictly followed.

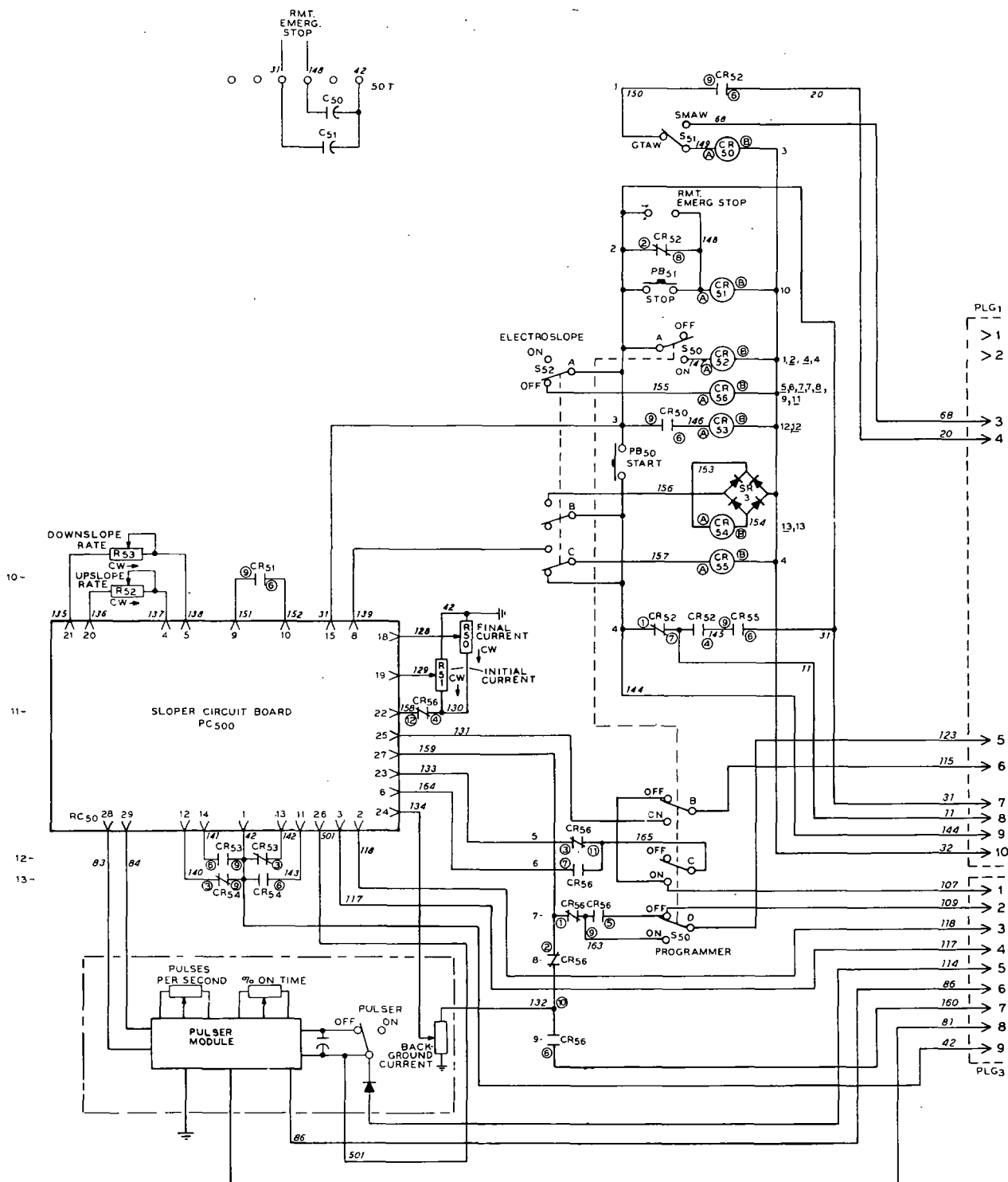
To distinguish between welding power source problems and Programmer problems, place PROGRAMMER switch in OFF position and use welding power source without Programmer. If the problem still exists, refer to welding power source Owner's Manual or contact the nearest Factory Authorized Service Station.

IMPORTANT: Before beginning troubleshooting procedures, recheck all switch positions and control settings and be sure unit is properly set up for the welding application.

Table 6-1. Troubleshooting

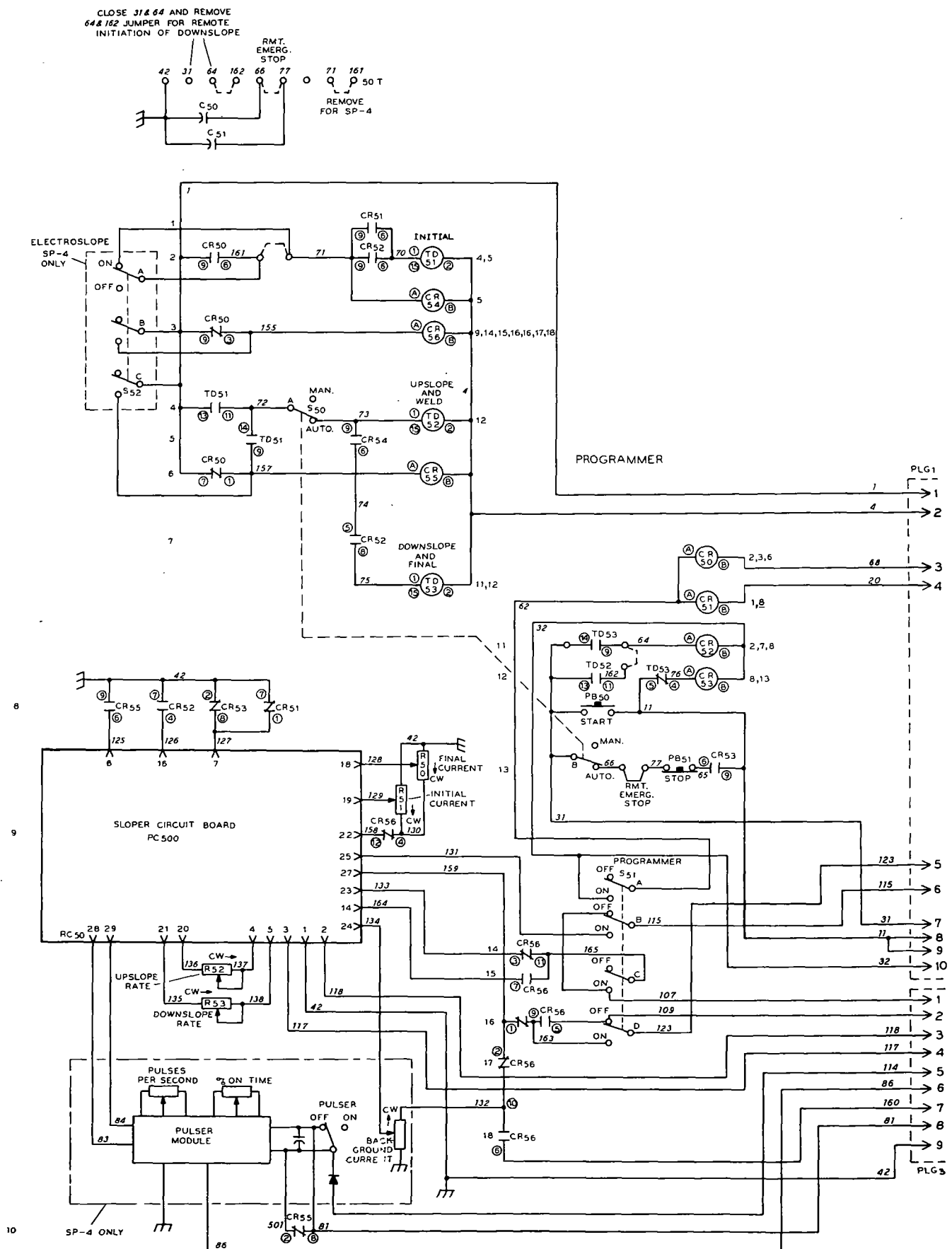
TROUBLE	CAUSE	REMEDY
No weld output.	No output from welding power source.	Turn Programmer off and check welding power source output. See welding power source Owner's Manual for troubleshooting information.
	Programmer controls set improperly.	Check all control settings.
	Improper remote control switches.	Check all switches and be sure they are as specified (see Sections 3-3 thru 3-6).
	Relay CR56.	Replace CR56.
	Sloper board PC500.	Replace PC500 (see Section 6-2).
Contactor always off or always on.	Welding power source not functioning properly.	Turn Programmer off and check welding power source functions. See welding power source Owner's Manual for troubleshooting information.
	Relay CR52, CR53, and/or CR55.	Replace relay(s).
	Sloper board PC500 (SP-1 and SP-2 models).	Replace PC500 (see Section 6-2).
Low or minimum weld output.	Welding power source not functioning properly.	Turn Programmer off and check welding power source functions. See welding power source Owner's Manual for troubleshooting information.
	Relay CR56.	Replace CR56.
	Sloper board PC500.	Replace PC500 (see Section 6-2).
Unit starts but stops as soon as Start switch is released.	Improper remote control switch.	Check switch and be sure it is as specified (see Section 3-5 or 3-6).
	Relay CR52, CR53, and/or CR55.	Replace relay(s).
Electroslope not working; weld output available.	Electroslope switch in OFF position.	Place switch in the ON position.
	Relay CR51, CR52, CR53, and/or CR55.	Replace relay(s).
	Sloper board PC500.	Replace PC500 (see Section 6-2).
Electroslope working; no weld output.	Sloper board PC500.	Replace PC500 (see Section 6-2).
Sequence timers do not time.	Relay CR50, CR51, CR53, and/or CR54.	Replace relay(s).
Pulser not working.	Pulser switch in OFF position.	Place switch in the ON position.
	Sloper board PC500 (SP-1 and SP-2 models).	Replace PC500 (see Section 6-2).
	Relay CR55.	Replace CR55.
Pulsing during initial and final condition.	Sloper board PC500 (SP-1 and SP-2 models).	Replace PC500 (see Section 6-2).
No pulsing, only peak amperage available.	Sloper board PC500.	Replace PC500 (see Section 6-2).
	Pulser board.	Replace pulser board (see Section 6-2).
No pulsing, no peak amperage adjustment.	Pulser board.	Replace pulser board (see Section 6-2).
Background amperage always minimum.	Sloper board PC500.	Replace PC500 (see Section 6-2).
	Pulser board.	Replace pulser board (see Section 6-2).





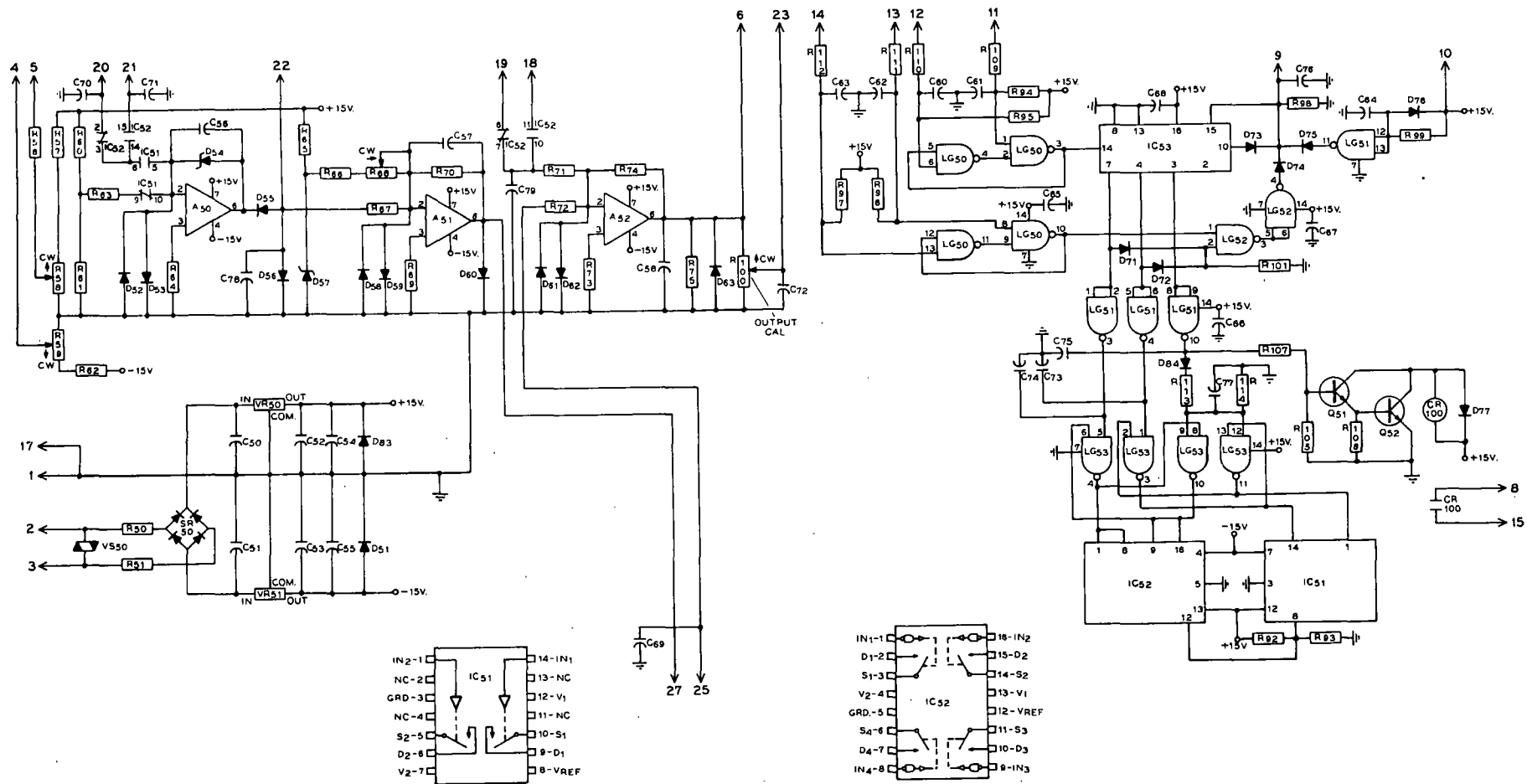
Circuit Diagram No. C-044 775

Diagram 7-2 . Circuit Diagram For SP-2 Models



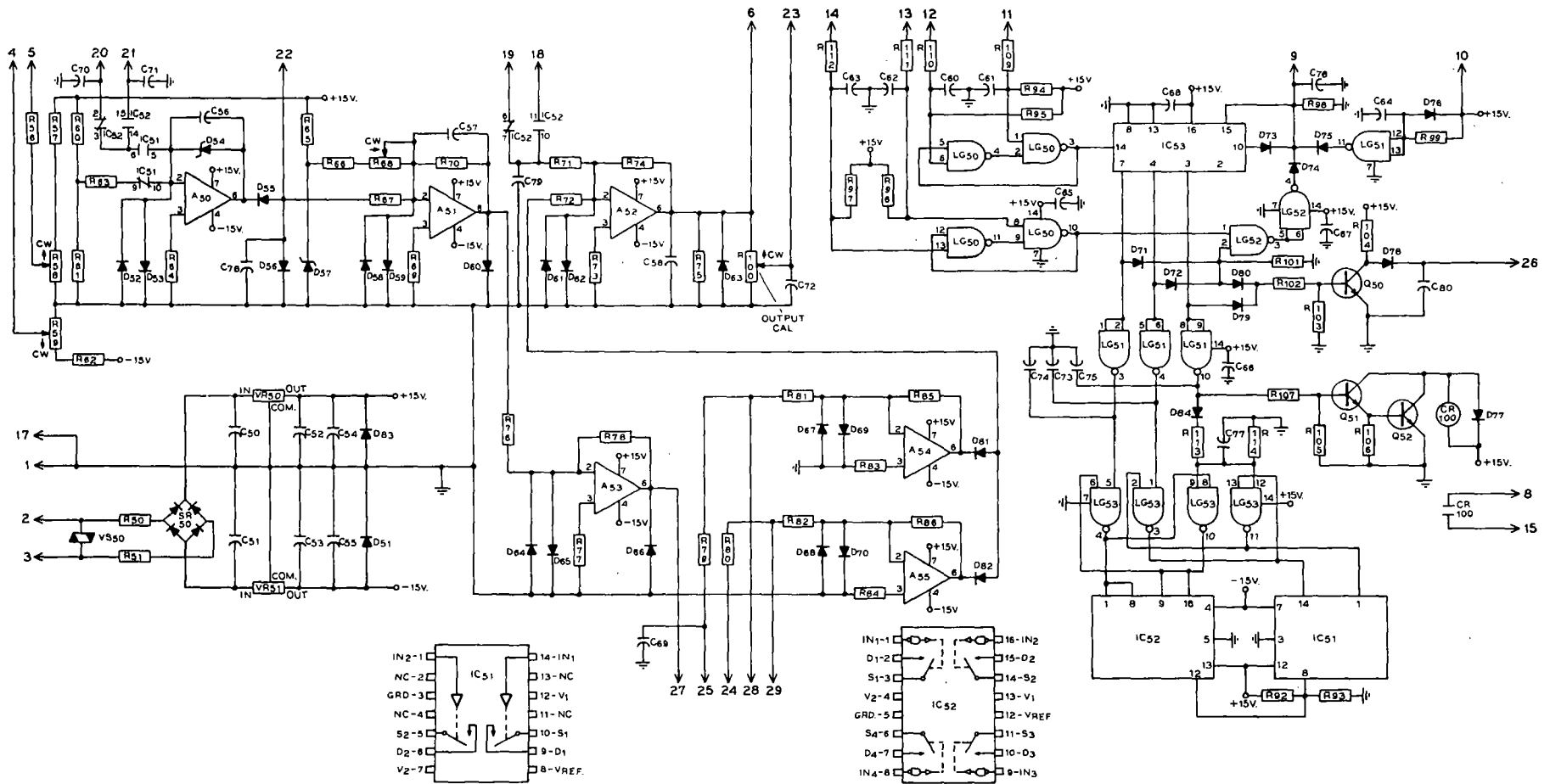
Circuit Diagram No. C-115 213-A

Diagram 7-3 . Circuit Diagram For SP-3 And SP-4 Models



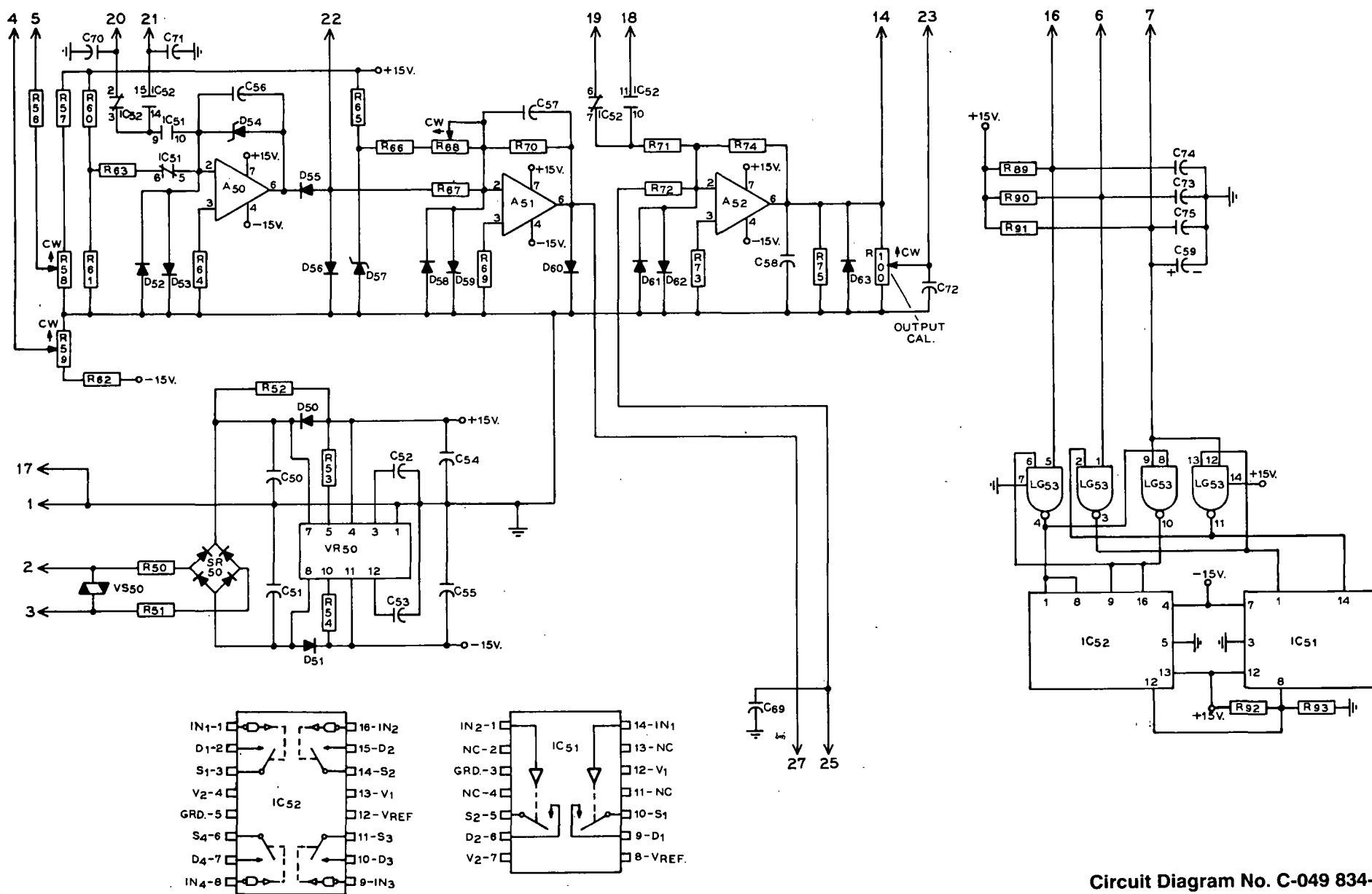
Circuit Diagram No. C-083 530

Diagram 7-4. Circuit Diagram For SP-1 Model Sloper Circuit Board PC500



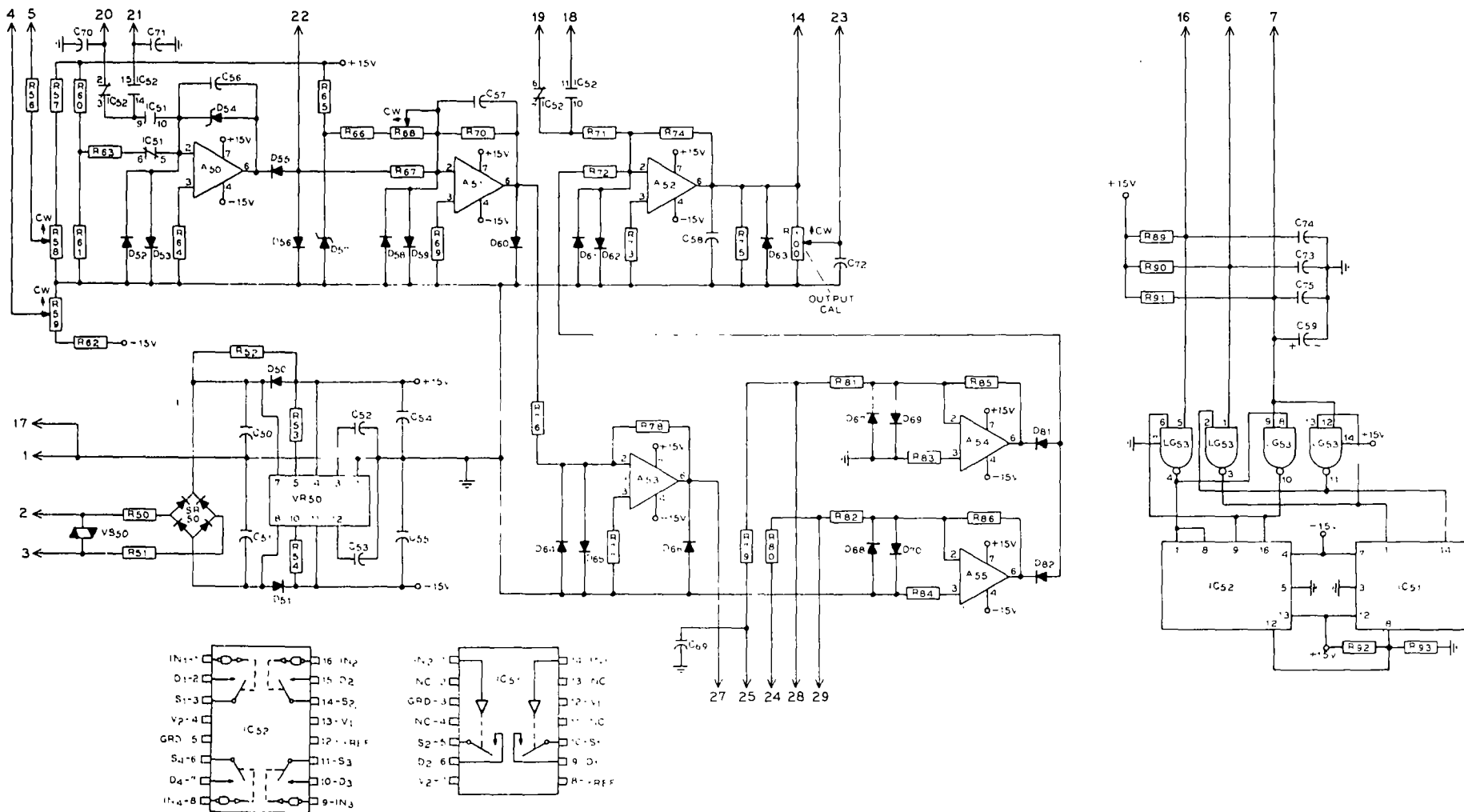
Circuit Diagram No. C-083 544

Diagram 7-5. Circuit Diagram For SP-2 Model Sloper Circuit Board PC500



Circuit Diagram No. C-049 834-A

Diagram 7-6. Circuit Diagram For SP-3 Model Sloper Circuit Board PC500



Circuit Diagram No. C-049 835-A

Diagram 7-7. Circuit Diagram For SP-4 Model Sloper Circuit Board PC500

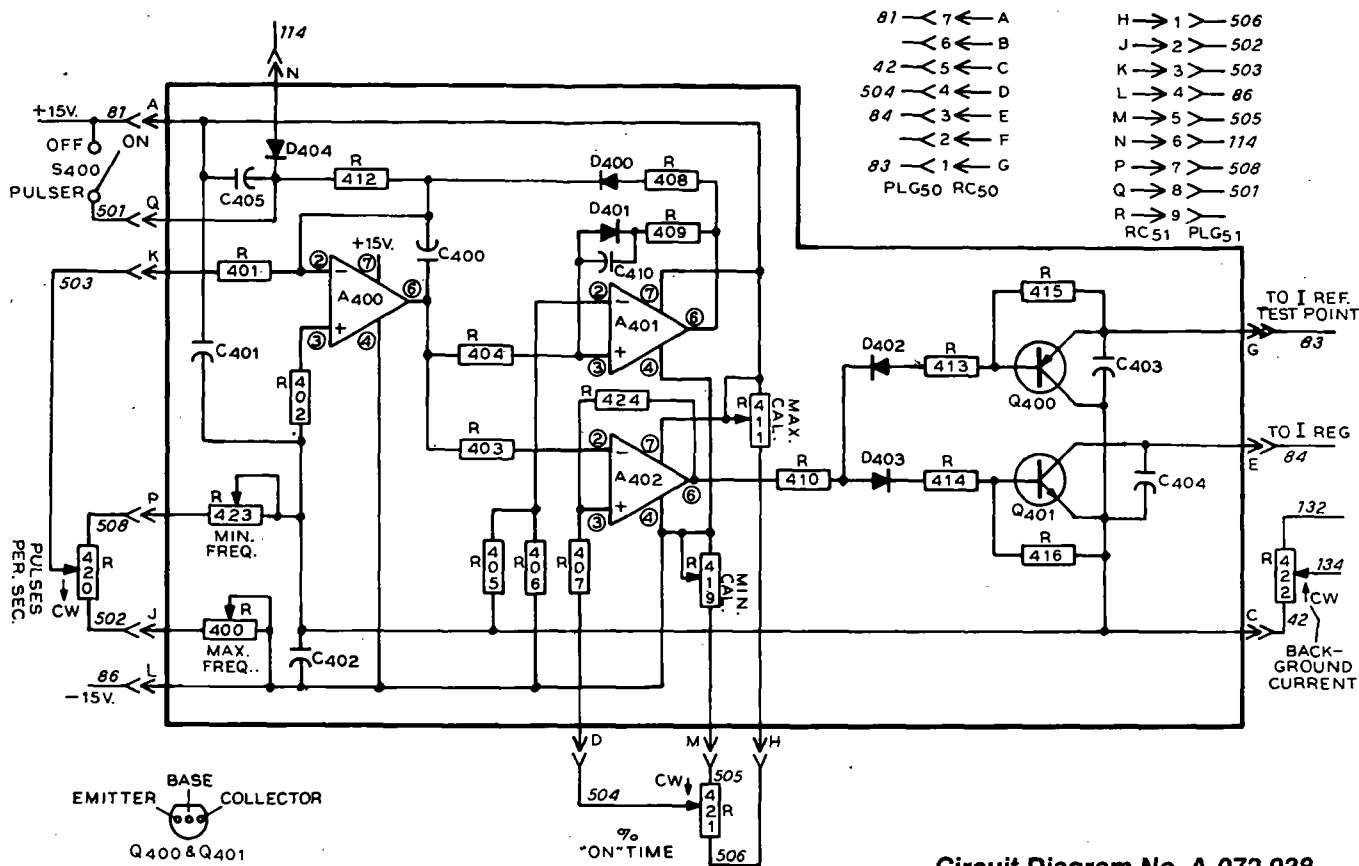
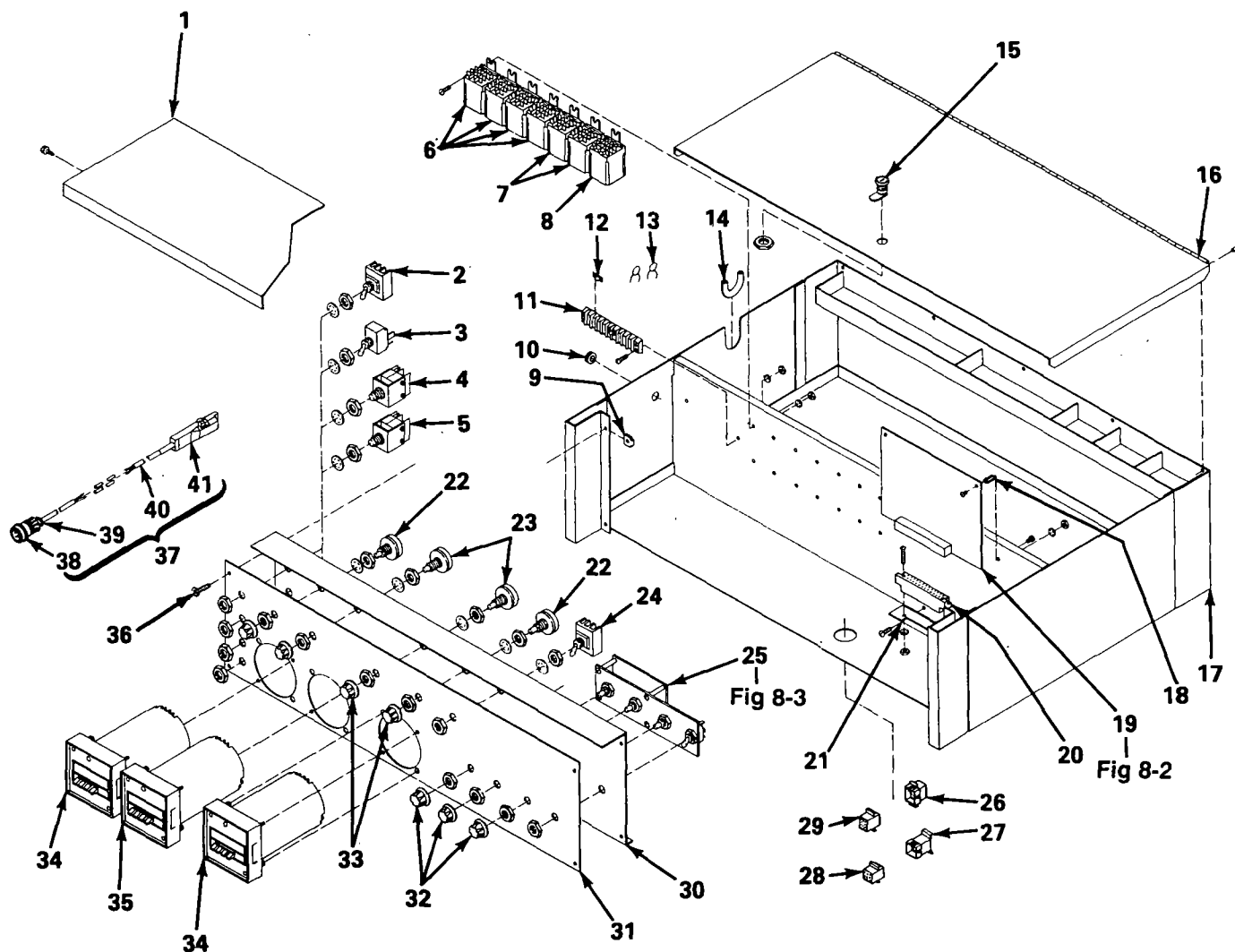


Diagram 7-8. Circuit Diagram For Pulser Circuit Board

SECTION 8 – PARTS LIST



TD-046 484-A

Figure 8-1. Main Assembly

Item No.	Dia. Mkgs.	Part No.	Description	Quantity			
				Model			
				SP-1	SP-2	SP-3	SP-4

Figure 8-1. Main Assembly

1		+008 872	COVER, top or	1	1	1	1
1		++052 302	COVER, top	1	1	1	1
		134 327	LABEL, warning general precautionary	1	1	1	1
		004 214	BUSHING, snap 1-5/8 ID x 2mtg hole	1	1	1	1
2	S51	011 609	SWITCH, tgl SPDT 10A 125V	1	1		
2	S51	052 769	SWITCH, tgl 4PDT 15A 125V			1	1
3	S50	052 769	SWITCH, tgl 4PDT 15A 125V	1	1		
3	S50	011 611	SWITCH, tgl DPDT 15A 125V			1	1
4	PB50	021 105	SWITCH/PUSH BUTTON, blk	1	1	1	1
5	PB51	021 106	SWITCH/PUSH BUTTON, red	1	1	1	1
6	CR50-53,55	000 174	RELAY, encl 24VAC 3PDT 10A	5	5		
6	CR50-53	000 174	RELAY, encl 24VAC 3PDT 10A			4	4
7	CR54	000 770	RELAY, encl 24VDC 3PDT w/flange	1	1		
7	CR54,55	039 498	RELAY, encl 120VAC 3PDT			2	2

Item No.	Dia. Mkgs.	Part No.	Description	Quantity			
				Model			
				SP-1	SP-2	SP-3	SP-4

Figure 8-1. Main Assembly (Continued)

8	CR56	049 181	RELAY, encl 24VAC 4PDT		1		
8	CR56	049 180	RELAY, encl 120VAC 4PDT			1	1
	SR3	035 704	RECTIFIER, integ 30A 600V	1	1		
9		605 670	NUT, speed 12-24	4	4	4	4
10		073 344	GROMMET, rbr 1/2 ID x 5/8mtg hole	1	1	1	1
11	50T	038 772	BLOCK, term 20A 6P	1	1		
11	50T	038 832	BLOCK, term 20A 9P			1	1
12		601 219	LINK, jumper term block 20A			3	2
13	C50,51	031 670	CAPACITOR, cer .05uf 500VDC	2	2	2	2
14		603 107	HOSE, 5/32 ID x 11/32 OD (order by ft)	1ft	1ft	1ft	1ft
15		009 502	LOCKSET	1	1	1	1
16		008 870	COVER, tool box	1	1	1	1
17		008 880	CHASSIS, ctrl and tool box	1	1	1	1
18		073 756	STAND-OFF, No. 6-32 x 5/8 lg 1/4 hex	2	2	2	2
19	PC500	083 409	CIRCUIT CARD, sloper and stepper (Fig 8-2)	1			
19	PC500	083 408	CIRCUIT CARD, sloper and stepper, pulser (Fig 8-2)		1		
19	PC500	048 246	CIRCUIT CARD, sloper (Fig 8-2)			1	
19	PC500	048 248	CIRCUIT CARD, sloper (Fig 8-2)				1
20	RC50	035 815	TERMINAL, hdr 29skt	1	1	1	1
21		009 556	BRACKET, mtg connector	1	1	1	1
22	R50,51	073 562	POTENTIOMETER, C 1/T 2W 10K ohm	2	2	2	2
23	R52,53	005 577	POTENTIOMETER, C 1/T 2W 200K ohm	2	2	2	2
24	S52	011 622	SWITCH, tgl 3PDT 15A 125VAC		1		1
25		008 508	PULSER, ctrl (Fig 8-3)		1		1
26	PLG1	072 802	HOUSING PLUG & PINS, (consisting of)	1	1	1	1
		009 419	TERMINAL, male	12	12	12	12
27	PLG3	008 072	HOUSING PLUG & PINS, (consisting of)	1	1	1	1
		058 971	TERMINAL, male	8	8	8	8
28	PLG4	008 073	HOUSING PLUG & SOCKETS, (consisting of)	1	1	1	1
		058 972	TERMINAL, female	8	8	8	8
29	PLG2	083 526	HOUSING PLUG & SOCKETS, (consisting of)	1	1	1	1
		009 418	RECEPTACLE, female	12	12	12	12
30		092 233	PANEL, front	1	1	1	1
31			NAMEPLATE, (order by model and serial numbers)	1	1	1	1
32		019 666	KNOB, line ind (Part of item 25)		3		3
33		019 666	KNOB, line ind	4	4	4	4
34	TD51,53	089 408	TIMER, digital (60 Hz) or			2	2
34	TD51,53	089 407	TIMER, digital (50 Hz)			2	2
35	TD52	088 892	TIMER, digital (60 Hz) or			1	1
35	TD52	089 406	TIMER, digital (50 Hz)			1	1
36		604 776	SCREW, panel mtg	4	4	4	4
37		130 155	SWITCH, hand remote (consisting of)	1	1		
38		111 122	HOUSING PLUG & PINS, (consisting of)	1	1		
		109 770	TERMINAL, male 1 pin sz45 16-22 wire	14	14		
39		116 964	CLAMP, cable 97-3057-1012	1	1		
40		604 525	CABLE, port No. 18 2/c (order by ft)	20ft	20ft		
41		009 835	SWITCH, w/leads	1	1		

+When ordering a component originally displaying a precautionary label, the label should also be ordered.

++This cover replaces cover on welding power source when programmer is used.

BE SURE TO PROVIDE MODEL AND SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS.

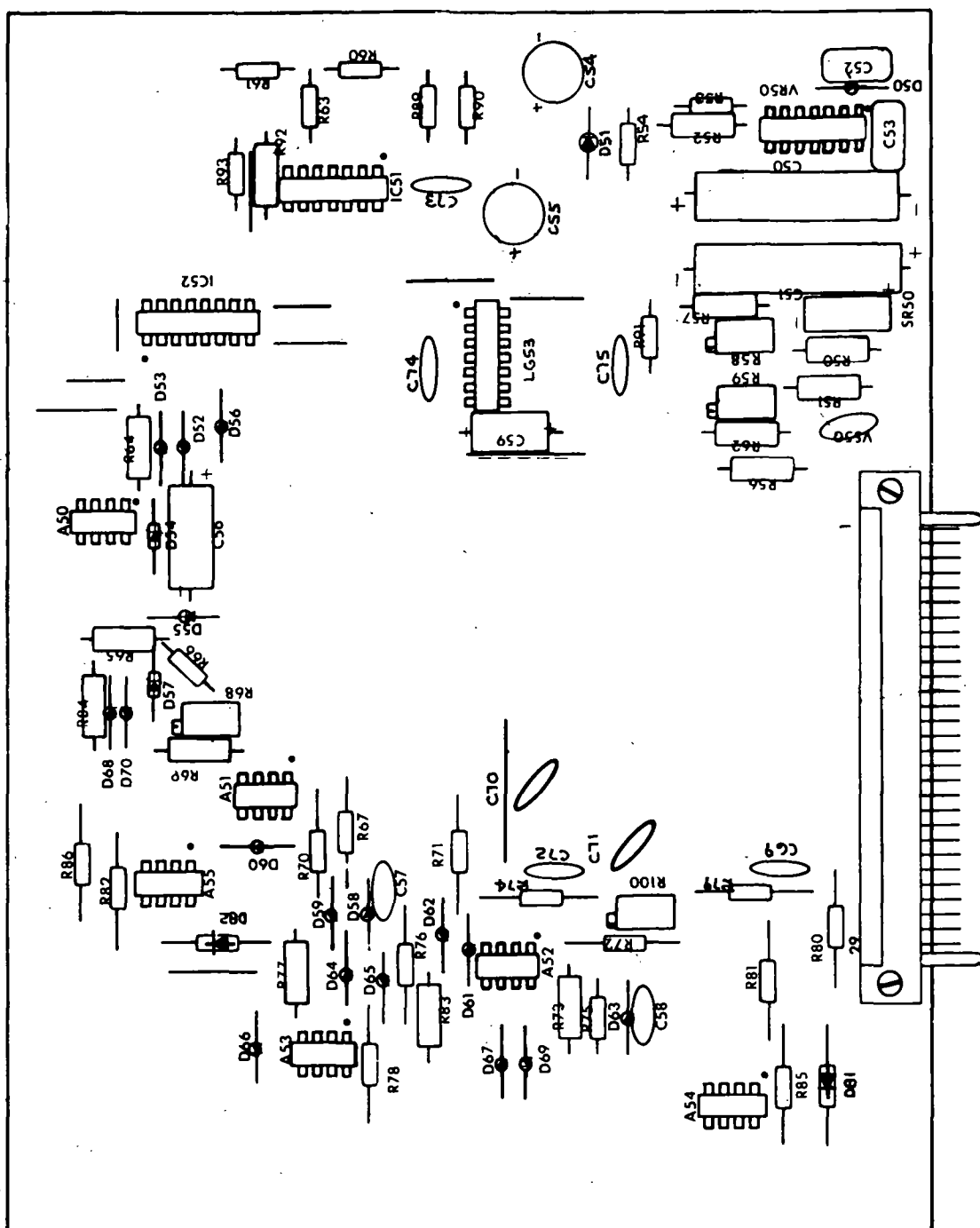


Figure 8-2. Circuit Card (Sloper And Pulser Illustrated)

C-111 316

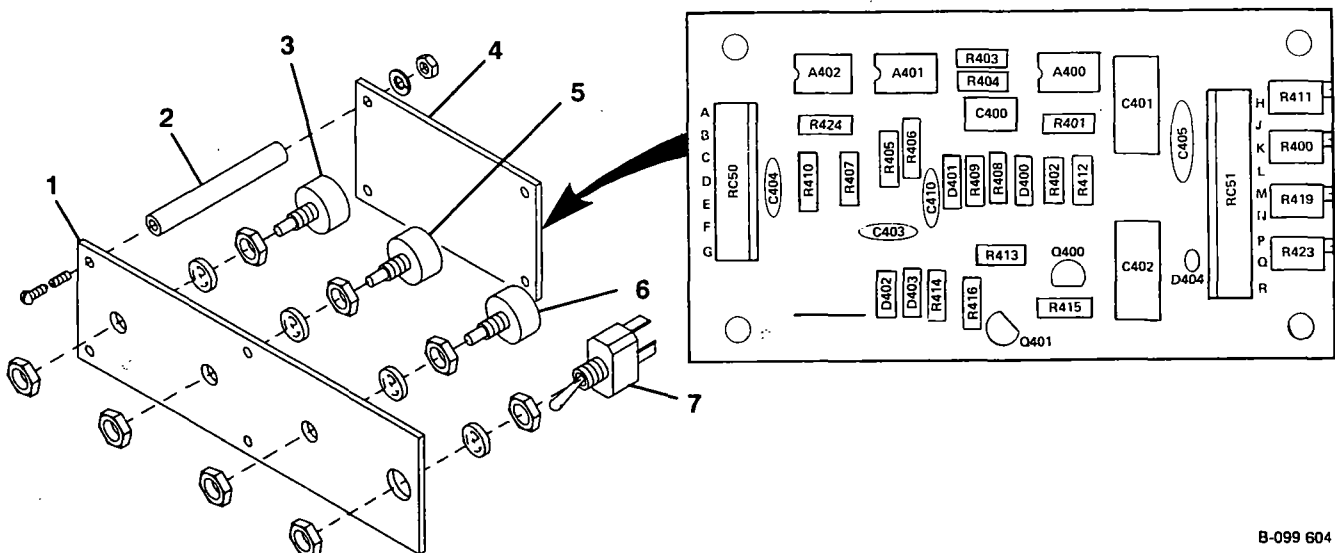
Dia. Mkgs.	Part No.	Description	Quantity			
			Model			
			SP-1	SP-2	SP-3	SP-4
		Figure 8-2. Circuit Card (Fig 8-1 Item 19)	083 409	083 408	048 246	048 248
A50	035 845	IC, linear 307	1	1	1	1
A51,52	008 971	IC, linear 741	2		2	
A51-55	008 971	IC, linear 741		5		5
C50,51	000 859	CAPACITOR, elctlt 220uf 35VDC	2	2	2	2
C52,53	035 832	CAPACITOR, mylar .0015uf 100VDC			2	2
C54,55	035 839	CAPACITOR, elctlt 22uf 35V	2	2	2	2
C56	031 628	CAPACITOR, elctlt 5uf 25VDC	1	1	1	1
C57,58,69,76	053 992	CAPACITOR, cer .001uf 1000VDC	4	4		
C57,58,69	031 646	CAPACITOR, cer .001uf 1000VDC			3	
C57,58,76	031 646	CAPACITOR, cer .001uf 1000VDC				3
C59	028 288	CAPACITOR, elctlt 8uf 25VDC			1	1
C52,53,60-63,65-68, 70,71,78,79	053 991	CAPACITOR, cer .05uf 500VDC	14			
C52,53,60-63,65-68, 70,71,78-80	053 991	CAPACITOR, cer .05uf 500VDC		15		
C64	028 288	CAPACITOR, elctlt 8uf 25VDC	1	1		
C70,71	031 670	CAPACITOR, cer .05uf 500VDC			2	2
C72-75	059 228	CAPACITOR, cer .02uf 500VDC	4	4		
C72-75	031 637	CAPACITOR, cer .02uf 500VDC			4	4
C77	003 530	CAPACITOR, cer 1uf 50V	1	1		
CR100	006 794	RELAY, reed 12VDC 1A SPST	1	1		
D51-53,55,56, 58-63,77,83	026 202	DIODE, 1A 400V SP	13			
D51-53,55,56, 58-70,77,78,83	026 202	DIODE, 1A 400V SP		21		
D50-53,55,56,58-63	026 202	DIODE, 1A 400V SP			12	
D50-53,55,56,58-70	026 202	DIODE, 1A 400V SP				19
D54	032 210	DIODE, zener 10V 1W SP	1	1	1	1
D57	037 386	DIODE, zener 11V 1W SP	1	1	1	1
D71-76,84	028 351	DIODE, sig .01A 75V SP	7			
D71-76,79-82,84	028 351	DIODE, sig .01A 75V SP		11		
D81,82	028 351	DIODE, sig .01A 75V SP				2
IC51	008 968	IC, interface 200	1	1	1	1
IC52	008 881	IC, interface 201	1	1	1	1
IC53	008 969	IC, interface 4017	1	1		
LG50-53	008 970	IC, digital 4011	4	4		
LG53	008 970	IC, digital 4011			1	1
Q51,52	037 200	TRANSISTOR, 200 MA 40V NPN	2			
Q50-52	037 200	TRANSISTOR, 200 MA 40V NPN		3		
R50,51	030 089	RESISTOR, C .5W 2.7 ohm	2	2	2	2
R52	030 038	RESISTOR, C .5W 220 ohm			1	1
R53,54	035 822	RESISTOR, CF .25W 10 ohm			2	2
R56	030 105	RESISTOR, C .5W 680 ohm	1	1	1	1
R57,62,64,69,73	030 021	RESISTOR, C .5W 4700 ohm	5		5	
R57,62,64,69,73, 77,83,84	030 021	RESISTOR, C .5W 4700 ohm		8		8
R58,59	005 022	POTENTIOMETER, cermet 25/T .5W 1000 ohm ..	2	2	2	2
R60,63,75,94-97,99	605 911	RESISTOR, C .25W 10K ohm	8			
R60,63,75,94-97, 99,104	605 911	RESISTOR, C .25W 10K ohm		9		
R60,63,75,89-91	605 911	RESISTOR, C .25W 10K ohm			6	6
R61,93,109-112	605 916	RESISTOR, C .25W 1K ohm	6	6		
R61,93	605 916	RESISTOR, C .25W 1K ohm			2	2
R65	030 033	RESISTOR, C .5W 470 ohm	1	1		
R65,92	030 033	RESISTOR, C .5W 470 ohm			2	2

Dia. Mkgs.	Part No.	Description	Quantity			
			Model			
			SP-1	SP-2	SP-3	SP-4
		Figure 8-2. Circuit Card (Fig 6-1 Item 19) (Continued)	083 409	083 408	048 246	048 248
R66	039 108	RESISTOR, CF .25W 82K ohm	1	1	1	1
R66	078 429	RESISTOR, C .25W 100K ohm			1	1
R67,70	030 044	RESISTOR, MF .25W 100K ohm	2		2	
R67,70,76,78,85,86	030 044	RESISTOR, MF .25W 100K ohm		6		6
R68	009 391	POTENTIOMETER, cermet 25/T .5W 50K ohm ...	1	1	1	1
R71,72,74	030 052	RESISTOR, MF .25W 1 meg ohm	3	3	3	3
R79-82	030 100	RESISTOR, MF .25W 50K ohm		4		4
R92	039 106	RESISTOR, CF .25W 470 ohm	1	1		
R98,107,113	074 041	RESISTOR, C .25W 47K ohm	3	3		
R100	004 596	POTENTIOMETER, cermet 25/T .5W 2K ohm	1	1	1	1
R101	078 429	RESISTOR, C .25W 100K ohm	1			
R101,102	078 429	RESISTOR, C .25W 100K ohm		2		
R103,105	035 886	RESISTOR, CF .25W 22K ohm		2		
R105	035 886	RESISTOR, CF .25W 22K ohm	1			
R106	035 823	RESISTOR, CF .25W 100 ohm	1	1		
R114	038 584	RESISTOR, CF .25W 470K ohm	1	1		
	092 648	RESISTOR, CF .25W zero ohm	2			
RC50	035 849	TERMINAL, hdr 29 pin	1	1	1	1
SR50	021 939	RECTIFIER, integ 1.5A 400V	1	1	1	1
VR50	083 772	IC, linear 78M15	1	1		
VR50	035 843	IC, linear 1468			1	1
VR51	046 932	IC, linear 7915	1	1		
VS50	035 227	VARISTOR, 8 joule 150V	1	1	1	1

BE SURE TO PROVIDE MODEL AND SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS.

Quantity	Model
	SP-2,SP-4

Item No.	Dia. Mkgs.	Part No.	Description	
008 508 Figure 8-3. Pulser Control (Fig 8-1 Item 25)				
1		003 513	STRIP, mtg controls	1
2		106 625	SPACER, 1/4 OD x 9/64 ID x 1 in	4
3	R422	035 897	POTENTIOMETER, C 1/T 2W 1000 ohm	1
4		072 811	CIRCUIT CARD, pulser (consisting of)	1
	A400-402	035 845	· IC, linear 307	3
	C400	003 530	· CAPACITOR, cer 1uf 500V	1
	C401,402	031 630	· CAPACITOR, elctlt 22uf 50VDC	2
	C403,404	000 340	· CAPACITOR, cer .01 50VDC	2
	C405	031 670	· CAPACITOR, cer .05uf 500VDC	1
	C410	052 141	· CAPACITOR, cer 33pf 1000V	1
	D400-403	028 351	· DIODE, sig .02A 75V SP	4
	D404	026 202	· DIODE, 1A 400V SP	1
	Q400	037 201	· TRANSISTOR, 200MA 40V PNP	1
	Q401	037 200	· TRANSISTOR, 200MA 40V NPN	1
	R400,411,419	039 359	· POTENTIOMETER, cermet 25/T .5W 5000 ohm	3
	R401	035 885	· RESISTOR, CF .25W 68K ohm	1
	R402	035 884	· RESISTOR, CF .25W 100K ohm	1
	R403-405,407,410	035 827	· RESISTOR, CF .25W 10K ohm	5
	R406	039 332	· RESISTOR, CF .25W 15K ohm	1
	R408,412	605 916	· RESISTOR, C .25W 1K ohm	2
	R409,413-416	039 331	· RESISTOR, CF .25W 4700 ohm	5
	R423	003 913	· POTENTIOMETER, cermet 25/T .5W 500 ohm	1
	R424	076 712	· RESISTOR, C .25W 220K ohm	1
		092 648	· RESISTOR, CF .25W zero ohm	1
	RC50	048 105	· TERMINAL, hdr 7 post	1
	RC51	072 670	· TERMINAL, hdr 9 post	1
5	R420	004 186	POTENTIOMETER, C 1/T 2W 5000 ohm	1
6	R421	030 109	POTENTIOMETER, C 1/T 2W 5000 ohm	1
7	S400	011 609	SWITCH, tgl SPDT 15A 125V	1



B-099 604

SB-046 481-B

Figure 8-3. Pulser Control

BE SURE TO PROVIDE MODEL AND SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS.



ERRATA SHEET

After this manual was printed, refinements in equipment design occurred. This sheet lists exceptions to data appearing later in this manual.

AMENDMENT TO SECTION 4 – OPERATOR CONTROLS

Amend the last paragraph of Section 4-6D. PULSER (SP-2 And SP-4 Models): Background Amperage Control
Rotating the control clockwise increases background amperage. The scale surrounding the BACKGROUND AMPERAGE control is calibrated in percent of full output of the machine, and should not be read as an amperage value.

AMENDMENT TO SECTION 8 – PARTS LIST

Amend Parts List as follows:

**	Dia. Mkgs.	Part No.	Replaced With	Description	Quantity
27-38		111 122	141 162	HOUSING PLUG & PINS, (Eff w/KB067430)	
				(consisting of)	1
			134 731	TERMINAL, male 1 pin 18-14 wire	14
27-39		116 964	143 922	CLAMP, cable strain relief sz 17 & 20	1
27-			130 003	CABLE, adapter (Prior to KC236118) (consisting of)	1
			039 273	PLUG, 5 pin MS-3106A-16S-8P	1
			039 685	CLAMP, cable AN-3057-1012	1
			052 246	CABLE, pwr No. 20ga 5/c (order by ft)	2ft
			116 964	CLAMP, cable 97-3057-1012	1
			137 301	RECEPTACLE, 14skt 97-3101A-20-27S-(431)	1
27-		137 301	152 568	HOUSING PLUG & SOCKET, (Eff w/KC236118)	
				(consisting of)	1
			141 685	TERMINAL, female 1skt 24-20 wire	14
			143 922	CLAMP, cable strain relief sz 17 & 20	1
29-	R52	030 038	028 282	RESISTOR, C .5W 220 ohm	1
29-	R57,62,				
	64,69,73	030 021	028 278	RESISTOR, C .5W 4.7K ohm	5
29-	R57,62,64,69,				
	73,77,83,84	030 021	028 278	RESISTOR, C .5W 4.7K ohm	8

**First digit represents page no - digits following dash represent item no.

BE SURE TO PROVIDE MODEL AND SERIAL NUMBER WHEN ORDERING REPLACEMENT PARTS.

FILE COPY
RETURN TO FOLDER

